DOCUMENT RESUME

ED 128 653 CE 008 123

AUTHOR	Smith, Robert Stewart
TITLE	The Occupational Safety and Health Act: Its Goals and Its Achievements. Evaluative Studies Series.
INSTITUTION	American Enterprise Inst. for Public Policy Research, Washington, D.C.
REPORT NO	VT-103-200
PUB DATE	76
NOTE	108p.
AVAILABLE FROM	American Enterprise Institute for Public Policy Research, 1150 Seventeenth Street, N. W., Washington, D. C. 20036 ($3.00)
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	Accident Prevention; *Environmental Research; *Federal Legislation; *Federal Programs; Health Programs; *Program Evaluation; *Safety; Standards; *Work Environment
IDENTIFIERS	Occupational Safety and Health Act 1970; Occupational Safety and Health Administration; OSHA

ABSTRACT

The safety and health mandate of the Occupational Safety and Health Act of 1970 is examined in reference to its effectiveness in reducing injuries and its consistency with the goal of promoting general welfare. Chapter 1 describes the essential features of the act and its administration to date, and analyzes the mandate as revealed by legislative intent and judicial decisions. Chapter 2 sketches a theory of social welfare and the conditions requiring the government to intervene in a market system to enhance this welfare. Chapters 3 and 4 discuss the Occupational Safety and Health Administration (OSHA) in terms of its decision on the noise standard, its enforcement program, and its success in reducing injuries. Alternative forms that a government program could take, and specific recommendations for change in the existing federal job safety and health program are offered in Chapter 5. Three appendices deal with technical aspects of the arguments developed in the chapters. (SH)

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ED128653

THE OCCUPATIONAL SAFETY AND HEALTH ACT

Its goals and its achievements

Robert Stewart Smith

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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VT-103-200

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ISBN 0-8447-3193-5

Evaluative Studies 25, January 1976

Library of Congress Catalog Card No. 75-39953

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CONTENTS

	INTRODUCTION AND SUMMARY	1
I	**THE OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970**	5
	Provisions of the Act	7
	The Safety and Health Mandate	14
	Issues for Further Consideration	17
II	**THE SOCIAL GOALS OF AN OCCUPATIONAL SAFETY AND HEALTH PROGRAM**	19
	A Safety Fable	20
	Are We Producing "Enough" Safety and Health?	26
	Benefit-Cost Studies	34
	Summary	37
III	**THE NOISE STANDARD: STANDARD-SETTING IN THEORY AND PRACTICE**	39
	Existing and Proposed Noise Standards	40
	OSHA's Decision: Some General Comments	41
	The Costs and Benefits of the OSHA and NIOSH Noise Proposals	45
	Summary	57
IV	**OSHA'S IMPACT ON WORK INJURIES**	59
	OSHA's Enforcement Program	59
	Estimated Impact of OSHA on Work Injuries	67
	Summary and Conclusions	70

V **ALTERNATIVES TO STANDARD-SETTING AND CONCLUDING RECOMMENDATIONS** 73
Summary of the Basis for a Government Safety and Health Program 74
Occupational Safety 74
Occupational Health 83
Recommendations 84

APPENDIX A: Intertemporal Variations in Work Injury Rates 87

APPENDIX B: The Job Safety Market: Econometric Evidence 89

APPENDIX C: Evaluation of the Target Industry Program 97

INTRODUCTION AND SUMMARY

The Occupational Safety and Health Act of 1970, which began with the overwhelming blessings of members of Congress, has turned out to be a difficult piece of legislation to implement. The Occupational Safety and Health Administration (OSHA), created as a Department of Labor agency to administer the act, has been pilloried for being both overly tough and entirely too weak. Pressured by Congress and labor groups to provide the highest possible degree of health and safety, as well as by the business interests that bear the initial costs of its programs, OSHA has produced inconsistencies making it vulnerable to criticism from both sides. The agency has refused (as of this writing) to reduce noise exposure limits to completely "safe" levels, yet has promulgated asbestos and vinyl chloride standards that permit almost no employee exposure at all. It has issued over 4,000 standards that employers must comply with, yet levies fines so small that the incentives for compliance are minimal.

The basic problem with the implementation of the act is that there is no fundamental agreement either on the act's goals or on the practical methods of balancing considerations of greater safety and health against considerations of cost. Worse yet, there is no agreement among policy makers or lobbyists even on the framework that should be used for the discussion of these issues--primarily because safety and health are generally regarded as "goods" of inestimable, if not infinite, value.

The purpose of this study is to evaluate the goals, the administration, and the impact of the Occupational Safety and Health Act of 1970. The focus is on such questions as the following: (1)

To what degree should the government attempt to require safety and health provisions? (2) Is there a clearly demonstrated need for the act? (3) What tools can OSHA use to guide its setting of standards, and how usable are the tools? (4) Has OSHA had an impact on injury rates? (5) Are there alternative methods the government could use to improve safety and health? Administrative foibles which are purely a function of the people involved in administering the act will be ignored.

In brief, the study argues that the safety and health mandate of the Occupational Safety and Health Act of 1970 is inconsistent with the goal of promoting the general welfare. A socially defensible goal for the act is set forth, along with a set of guidelines and tools for analyzing policy choices in the safety and health area. The government, it is argued, should not force more safety and health on society than workers would choose for themselves if they had to pay the costs of safety and health directly. This criterion for standard-setting is the basis for benefit-cost analysis, which is illustrated by a look at the standard for workers' exposure to industrial noise. It is argued that neither of the two noise standards being considered in mid-1975 was likely to advance the general welfare.

The study also demonstrates that the current program is likely to be ineffective in reducing injuries. Not only are the incentives for compliance with the act weak, but the standards are so unrelated to the major causes of occupational injury that even perfect compliance would have a limited effect on injuries. Not surprisingly, the observed impact on injury rates of a special program aimed at especially hazardous industries is nil.

The study argues that a less costly and more effective way to reduce work injuries would be to repeal all standards and, instead, fine employers for every injury to their workers. The special characteristics of occupational disease do, however, require that the standards approach be central to an occupational health program.

Chapter I describes the essential features of the act and its administration to date. It also analyzes the mandate for safety and health, as revealed by legislative intent and judicial decisions, and concludes that the legal mandate is for virtually absolute worker protection. Cost considerations seem to be allowed only if an entire industry would be shut down by an OSHA requirement.

Chapter II sketches a theory of social welfare and the conditions requiring the government to intervene in a market system to enhance this welfare. It is this theory which suggests that the

government should seek to provide that amount of safety and health which workers would provide for themselves if they did not have an employer standing between them and the producers of safety and health devices (or safety and health training). The chapter argues that, as consumers, people choose to take risks greater than the technically possible minimum; it is therefore unlikely that workers would want to give up the goods and services required to produce absolute safety and health on the job. Thus, the safety and health mandate discussed in Chapter I sets for OSHA a goal that will probably reduce social well-being. Chapter II also considers the need for the act—a need compelling in the health area but not especially so in the area of occupational safety—and, as I have noted, provides the theoretical basis for benefit-cost analysis, which is argued to be the best tool with which to analyze proposed standards.

Chapter III demonstrates the use of benefit-cost analysis in the health area by analyzing the noise standard OSHA was considering in mid-1975. The study suggests that both of the noise exposure limits OSHA has considered would require more quiet than workers would desire if they paid the costs of attaining those noise levels directly. More important, however, the analysis illustrates the practicality, strengths, and weaknesses of using benefit-cost studies to aid decision making by OSHA.

Chapter IV evaluates the potential and actual effects of OSHA on work injury rates, given the characteristics of OSHA's enforcement process. The chapter demonstrates that the incentives for compliance in advance of inspection are very small indeed and that, moreover, even perfect compliance would have only a limited impact on worker injuries. It is not surprising, then, that no measurable effects can be found from a special OSHA program for high-risk industries.

Chapter V builds on the weaknesses of the standard-setting approach to occupational safety and suggests, as an alternative, the adoption of an approach that fines the employer for each work injury in his plant. This approach, it is argued, would be more effective and less wasteful than the current approach. Standards for dealing with occupational health problems would have to be retained, however. The chapter makes some specific recommendations for change in the existing federal job safety and health program.

Three appendices deal with technical aspects of the arguments developed in the chapters.

CHAPTER I

THE OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

. . . [T]oday we are considering one of the truly great landmark pieces of social legislation in the history of this country. The occupational safety and health bill which has been agreed to by the House and Senate conferees provides over 80 million American industrial workers with the protection they so desperately need to insure that they have a safe and healthy place to work.

U.S. Senator Ralph Yarborough, 1970

The Occupational Safety and Health Act of 1970 was enacted into law with the widespread belief that the safety and health dangers facing American workers were intolerably large and becoming worse. Fully 3 percent of the employed civilian labor force were injured seriously enough each year so that sick leave was required, these injuries causing the loss of over 100,000 man-years of production. Further, the safety of workers appeared to be steadily declining. The manufacturing injury rate had risen from 11.1 lost-time injuries per million man-hours in 1957 to 15.2 by 1970. The Labor Committee of the House of Representatives noted that this "upward trend shows no signs of change," and the Labor Committee of the Senate stated, "The knowledge that the industrial accident situation is deteriorating, rather than improving, underscores the need for action now." [1]

Although less was known about occupational disease than injuries, it was estimated that only 25 percent of workers exposed

[1] Bureau of National Affairs, *The Job Safety and Health Act of 1970* (Washington, D. C.: Bureau of National Affairs, Inc., 1971), pp. 173, 218.

to health hazards were adequately protected and that 390,000 new cases of occupational disease arose each year.[2] Health hazards also appeared not to be diminishing. Indeed, one doctor, testifying about asbestosis (the scarring of lungs due to asbestos dust), remarked, "It is depressing to report, in 1970, that the disease that we knew well 40 years ago is still with us just as if nothing was ever known."[3]

Setting aside (until the next chapter) the question whether the existence of high or rising injury/illness rates constituted a valid basis for the 1970 act, it is interesting to consider at this point the congressional "finding" that occupational safety had been deteriorating over time. One must filter out short-term changes in injury rates in order to find a "trend." Yet one looks in vain through the congressional debate for any recognition of the fact that the injury rate is sensitive to short-run changes in business conditions. The cyclical nature of work injury rates was first noted around 1940,[4] and it has been estimated that in the postwar period a two percentage-point reduction in the overall unemployment rate was associated with one additional (manufacturing) lost workday injury per million man-hours worked.[5] While the reasons for the cyclical variation in work injury rates are less well-established, I have found that work injuries rise as overtime, hiring rates, and percent of plant capacity utilized rise. (See Appendix A for a fuller and more technical summary of the evidence on intertemporal variations of the work injury rate.) If, as one can reasonably conjecture, injuries rise with fatigue, worker inexperience, and the pace of production, it is important to adjust for cyclical variations in these factors before concluding that a "trend" is manifest—particularly in view of the fact that the late 1960s, when injury rates rose most dramatically, were a period of exceptionally tight labor markets.

The evidence for the existence of a trend in the overall manufacturing injury rate is mixed. If one begins the analysis immediately after World War II (when injury rates were high), there appears to be no trend at all after cyclical influences are

[2] Ibid., p. 13.

[3] Ibid., p. 219.

[4] Max D. Kossoris, "Industrial Injuries and the Business Cycle," *Monthly Labor Review*, March 1938, pp. 579-594, and "Changes in Injury Frequency Rates and Employment in Manufacturing, 1936-41," *Monthly Labor Review*, May 1943, pp. 949-954.

[5] Robert S. Smith, "Intertemporal Changes in Work Injury Rates," *Proceedings of the Industrial Relations Research Association* (1973), pp. 167-174.

accounted for (see Appendix A). However, beginning with the mid-1950s as a point of reference, there does appear to be a sharp upward "trend" after 1966. Figure 1 displays the actual manufacturing injury rate each year from 1956 to 1970 and the rate adjusted for changes in overtime, hiring rates, and capacity utilization. Adjustment for cyclical influences moderates the apparent trend in the raw data: for example, the raw data show the upward "trend" developing after 1953, while the adjusted data do not have an upward "trend" until after 1966. Nevertheless, even the adjusted series shows a steep rise in the late 1960s—indicating that more than the usual cyclical factors was behind the increase in work injuries over that period. Whether this recent increase can be called a "trend" or not is a matter of definition, but nonetheless, it is a troubling development for which no underlying causes have yet been identified.

Despite these rather qualified findings for the existence of a trend, so overwhelming was the case for federal safety and health legislation considered to be that every witness before the House subcommittee holding hearings on the bill agreed that there was a need for the legislation.[6] Indeed, the initial House and Senate versions of the act passed by margins of 383 to 5 and 83 to 3, respectively. The votes reflected the widespread conviction that existing state safety legislation was generally weak or not well-enforced, and that variations in safety requirements across states tended to penalize those where concern for safety was strongest.

Provisions of the Act

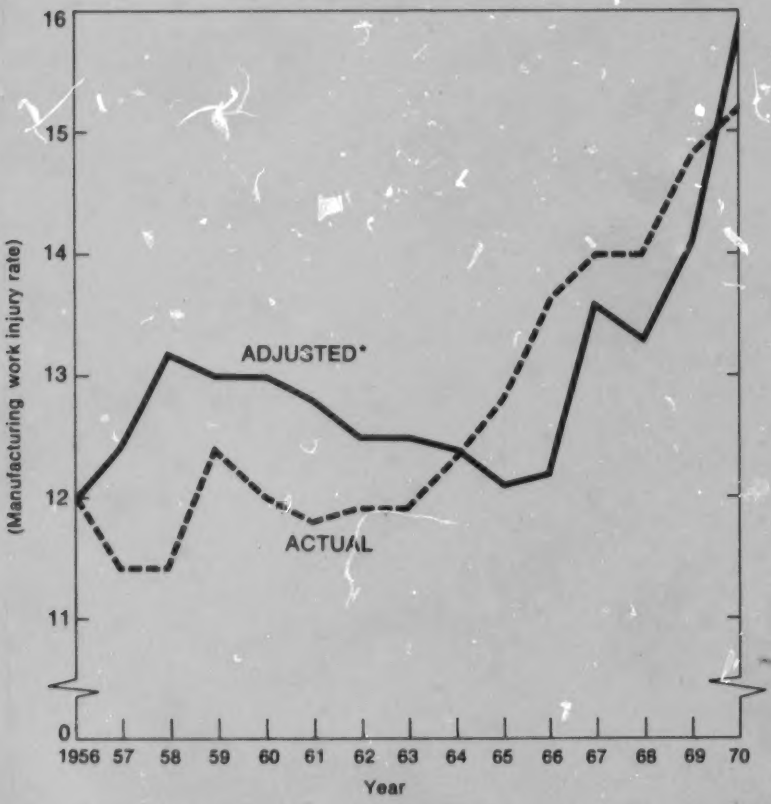
The Occupational Safety and Health Act, whose purpose is "to assure safe and healthful working conditions for working men and women," became law on April 28, 1971. It directs the secretary of labor to establish and enforce safety and health standards for all enterprises engaged in business affecting interstate commerce; the only exempt employers are federal, state, and local governments. Over 4.1 million employers and some 57 million employees are covered by the act.

Employer Duties. Under the act, each employer is required to comply with the standards promulgated by the Occupational

[6] U.S. Congress, Senate, Committee on Labor and Public Welfare, *Legislative History of the Occupational Safety and Health Act of 1970* (Washington, D. C.: U.S. Government Printing Office, 1971), p. 1003.

Figure 1

ACTUAL AND ADJUSTED INJURY RATES IN MANUFACTURING, 1956–70



Note: The adjusted rates are calculated by adding to the actual rates a positive or negative cyclical component due to changes, after 1956 in overtime, hiring rates, and capacity utilization. The formula used to calculate this component was derived from equation (A.2) in Appendix A. The formula was as follows: $.556\ (\Delta H)_t + .602\ (\Delta A)_t + .071\ (\Delta C)_t$, where ΔH_t, ΔA_t and ΔC_t are the changes from 1956 to year t in overtime hours, the accession rate, and the capacity utilization rate. In other words, the adjusted rates are those estimated to have existed if there had been no changes since 1956 in overtime hours, hiring rates, and capacity utilization.

Sources: U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics 1972*, Bulletin 1735 (Washington, D. C., 1972), p. 361; U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*, Continuation to 1962 (Washington, D. C., 1965), Table D785.

Safety and Health Administration. In addition, every employer is required to furnish for each of his employees a job which is "free from recognized hazards that are causing or likely to cause death or serious physical harm" [section 5(a)(1)]. While this "general duty" clause might appear to be an all-encompassing requirement for the provision of safety, it was clearly the intent of Congress that the clause be limited in scope and relied upon infrequently. "Recognized hazards" are defined in the congressional debate as those which can be detected by the common human senses, unaided by testing devices, and which are generally known in the industry to be hazards. Further, a firm can be penalized under the "general duty" clause only if the unsafe condition has been cited by an inspector and the employer has refused to correct it in the specified time.[7] Finally, the harm to be protected against is physical, not emotional, harm.[8] Thus, the general duty of each employer is qualified.

The entire responsibility for compliance with the act is placed on employers. Employees are nominally required to comply with applicable standards, but there are no provisions in the law for penalizing them if they do not.

Standards. Provided for in the act are the issuance of three kinds of safety and health standards by the secretary of labor. Interim standards were to be published immediately after the effective date of the act and could be issued for two years thereafter. These standards were restricted to "established Federal standards," such as those applicable to federal contractors and suppliers under the Walsh-Healey act, and national "consensus standards." A "consensus standard" was defined (section 3) as one issued by a nationally recognized standards-producing organization under conditions of "substantial agreement," after diverse views were permitted to be heard. The only standards meeting the definition were those of the American National Standards Institute and the National Fire Protection Association, both of which are private organizations which had set voluntary standards before the act. Roughly 45 percent of OSHA's 4,400 interim standards came from the two consensus organizations; the rest of those initially promul-

[7] Bureau of National Affairs, *Job Safety and Health Act*, p. 41.

[8] Richard S. Miller, "The Occupational Safety and Health Act of 1970 and the Law of Torts," *Law and Contemporary Problems*, Summer-Autumn 1974, p. 627.

gated already existed under the Walsh-Healey, Construction Safety, and Longshoring Safety acts.[9]

On the foundation provided by the interim standards, the secretary of labor is directed to issue other standards whenever he becomes convinced of their need. These standards are to be adopted only after a careful review process has been completed—a process which may involve the National Institute of Occupational Safety and Health (NIOSH), the agency set up under the act in the Department of Health, Education and Welfare to conduct research on occupational safety and health. The secretary of labor may ask for recommendations on his proposed standard from an advisory committee, but must publish the proposal in the *Federal Register* and hold public hearings if written objections are received. Only after the hearings can a standard be promulgated, although its effective date may be delayed ninety days in order for employers to become familiar with it. Considerations to be taken into account in setting standards, in addition to attainment of the highest degree of protection to the employee, include (1) the feasibility of the standards, (2) the latest scientific evidence in the field, and (3) previous experience under other laws [section 6(b)(5)]. In its first four years of operation, OSHA promulgated only four major standards under this "permanent" procedure—standards relating to mechanical power presses, asbestos dust, the fourteen carcinogens, and vinyl chloride. The last three have been reviewed by federal courts of appeals.

The secretary of labor may also promulgate temporary standards, to become effective on the date of publication in the *Federal Register*. These standards may only be promulgated if the secretary determines that employees are exposed to some "grave danger" and that a standard is needed to protect them. Immediately upon publication of a temporary standard, the secretary must begin the proceedings described above for regular standards, and within six months the temporary standard must be replaced by a permanent one.

An employer may be granted a permanent variance from a standard, after an inspection and a hearing which his employees can attend, if he can demonstrate by a preponderance of evidence that he provides employment as safe and healthful as he would if he complied with the standard. A temporary variance may be issued to an employer if, after a hearing which his employees may

[9] Bureau of National Affairs, *Occupational Safety and Health Reporter: Current Report*, May 6, 1971, p. 6.

attend, the employer is able to demonstrate he cannot comply with the standard by its effective date because of labor or materials shortages, that he is taking all available steps to safeguard his employees against the hazard covered by the standard, and that he has a program to come into compliance as soon as possible. A temporary variance, including renewals, cannot last for more than two years. The economic impact of compliance with a standard is not to be considered in the decision to grant a temporary variance, according to congressional intent.[10]

Variances are, in fact, not widely sought or approved. From its inception to the end of 1974, OSHA has closed only 487 applications for variances. Of these, 212 were denied or withdrawn and the rest were, in effect, granted.[11]

The standards OSHA enforces cover 800 pages in the Code of Federal Regulations and number close to 4,400—with 2,100 applying to all industries and the remainder to construction and maritime industries. To indicate the diversity of standards adopted, the 140-odd regulations pertaining to portable wood ladders range from general housekeeping requirements:

> Ladders should be stored in such a manner as to provide ease of access or inspection, and to prevent danger of accident when withdrawing a ladder for use,[12]

to specific construction criteria:

> The minimum width between side rails at the top, inside to inside, shall be not less than 11 and ½ inches. From top to bottom, the side rails shall spread at least one inch for each foot of length of stepladder,[13]

to those standards for which a layman must find it difficult to assess his performance:

> The general slope of grain and that in areas of local deviations of grain shall not be steeper than 1 in 15 in rungs and cleats. For all ladders cross grain not steeper than 1 in 12 are permitted in lieu of 1 in 15, provided the size is increased to afford at least 15 percent greater calculated strength for ladders built to minimum dimensions.

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[10] U.S. Senate, *Legislative History of the Occupational Safety and Health Act of 1970*, p. 1201.

[11] Bureau of National Affairs, *OSH Reporter: Current Report*, January 30, 1975, p. 1058.

[12] *U.S. Code of Federal Regulations*, Title 29, Section 1910.25(d)(1)(v).

[13] Ibid., Section 1910.25(c)(2)(i)(c).

Local deviations of grain associated with otherwise permissible irregularities are permitted.[14]

Enforcement. Inspections are the method by which compliance with the act is determined. The Department of Labor may schedule inspections in response to employee complaints or may make them in the course of its regular inspection program, for which the Senate Labor Committee recommended a "worst-first" approach.[15] In both cases, the giving of advance notice of the inspection is prohibited. The act specifies that representatives of both the employer and his employees shall be given an opportunity to accompany the inspector.

If inspection discloses a violation, the employer is cited, ordered to comply within a specified abatement period, and may be fined. Serious violations, ones which create a substantial probability of death or serious physical harm, must be fined up to $1,000 for each violation, but fines for each nonserious violation, although permitted, are not required. Willful or repeated violations may result in a civil penalty of $10,000 for each violation, and failure to correct a violation within the abatement period may result in a fine of $1,000 per day. The only criminal penalties for violations of standards attach to willful violations which lead to death of an employee; in these cases, a fine up to $10,000 and a jail sentence of up to six months are authorized. In its first forty-six months of operation, OSHA made 213,400 inspections, citing 145,300 employers for 750,700 violations. The average proposed penalty per violation was about $25.[16]

Employers may appeal citations to the Occupational Safety and Health Review Commission, a three-member body appointed by the President. The commission had received a total of 11,600 petitions by the end of 1974 and had decided 9,130. Over half of the decisions concerned periods of abatement, and in 90 percent of these cases the commission allowed the employer more time to abate a violation.[17] Further evidence of the commission's tendency to mitigate OSHA's enforcement is that in one-third of its most important decisions during 1971 and 1972, the commission vacated the contested citation, while in another third of the

[14] Ibid., Section 1910.25(b)(3)(ii).

[15] Bureau of National Affairs, *Job Safety and Health Act*, p. 44.

[16] Bureau of National Affairs, *OSH Reporter: Current Report*, April 24, 1975, p. 1538.

[17] Ibid., January 30, 1975, p. 1066.

cases the penalty for the violation was reduced.[18] Decisions of the commission are subject to review, if desired, by the federal courts of appeals.

If an inspector determines that imminent danger of death or serious physical harm exists in a workplace, the secretary of labor can seek an injunction closing down the work site until the hazard is eliminated. A provision permitting the secretary to close down a site administratively was not adopted.

State Plans. The act permits states to adopt their own safety and health standards and programs so long as the state designates an agency to administer the program, gives the agency sufficient legal authority and funding to enforce standards which must be "at least as effective" as the federal standards in providing safe and healthful employment, prohibits advance notice of inspections, and meets a few other specified criteria. The act directs the secretary to decide whether to accept or reject state plans, directs him to monitor them, and to revoke approval if the state fails to comply with any of the provisions or assurances related to the provisions in its plan.

One criterion to be used in judging whether standards are "as effective as" the federal standards is—presumably—their stringency. In the debate in the House, it was recognized that a state requirement that work benches be two-and-one-half feet apart would not be judged "as effective as" a federal requirement that they be three feet apart.[19] Other criteria for judging state standards or their enforcement are not indicated either in the act or in its legislative history.

The most apparent reason why states were allowed to operate their own programs—in the face of the general conclusion that state programs were poorly run before the act—is that the congressmen believed the safety-conscious states would want to maintain their current safety enforcement efforts and perhaps even adopt more stringent requirements than the federal standards. In addition, safety was seen as the historical responsibility of the states, and a responsibility the federal government should preempt only if the states were not willing to adopt an effective program.[20] However, by the end of 1974, only fifteen states and

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[18] Bureau of National Affairs, *Daily Labor Report*, February 24, 1975, p. D-10.

[19] Bureau of National Affairs, *Job Safety and Health Act*, p. 311.

[20] U.S. Senate, *Legislative History of the Occupational Safety and Health Act of 1970*, pp. 339-341, 997.

one territory had fully operating plans, and three of the remaining ten states with approved (but not operational) plans—Illinois, New Jersey, and New York—had announced their intentions to give up their state programs.[21] The apparent weakening of interest in state-run programs comes partly from the opposition of organized labor—which regards state plans as a dilution of the safety and health commitment—and partly from state budgetary problems (state programs receive only 50-percent federal reimbursement).

Other Provisions. Three other provisions of the act are worth mentioning in the context of program operation. First, employers are required to keep records of occupational injuries and illnesses, and must, in addition, keep records of employee exposure to potentially toxic materials. Second, the act authorizes the secretary to conduct training of employees and employers in the area of good safety and health practices. Third, the only concession to small businesses is the provision allowing for Small Business Administration loans to small businesses whenever compliance with standards will cause substantial economic injury without such loans.

The Safety and Health Mandate

With a program as immense and complex as that set up under the Occupational Safety and Health Act, it is not surprising that many legal, procedural, and administrative problems have surfaced.[22] Although many of these issues concern OSHA's enforcement program, the fundamental disagreement in most cases is how much safety and health OSHA should require for American workers. Although the following two chapters will consider this fundamental problem in a formal way, it will be useful here to review congressional and judicial opinions on how far OSHA should go in protecting workers from injuries and disease.

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[21] Bureau of National Affairs, *OSH Reporter: Current Report*, April 24, 1975, p. 1539.

[22] For discussions of some of these issues, see Miller, "Occupational Safety and Health Act of 1970 and the Law of Torts," and the report of the AFL-CIO reprinted in Bureau of National Affairs, *Daily Labor Report*, February 24, 1975. Other articles are Richard S. Morey, "Mandatory Occupational Safety and Health Standards—Some Legal Problems," and Joseph Page and Peter Munsing, "Occupational Health and the Federal Government: The Wages Are Still Bitter," in *Law and Contemporary Problems*, Summer-Autumn 1974, pp. 584-611 and 651-668, respectively.

The preamble to the act states that its intent is to "assure safe and healthful working conditions for working men and women," and the secretary is directed to implement standards which attain the "highest degree of health and safety protection for the employee" [section 6(b)(5)]. On the other hand, the secretary is also legally required to take into account "feasibility" when developing a standard. Aside from the requirement to consider past experience and recent scientific data, the act contains no guidelines on standard-setting other than to require that standards concerning toxic materials must "assure, to the extent feasible, . . . that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life" [section 6(b)(5)].

The crucial qualification to OSHA's otherwise apparent mandate to ensure absolute safety for employees is the idea of "feasibility," left vague and ill defined by Congress. The debate over "feasibility" has centered on whether Congress meant that a standard must be technologically achievable, or that the cost of achieving the standard should somehow be weighed in the promulgation process. Given the importance of the issue, it is astounding to discover the virtual absence of congressional debate or explanation of "feasibility." The original bill which cleared the House contained no reference to feasibility—indeed, it contained no guidelines for standard-setting at all. Yet, when "feasibility" was introduced in conference, no mention of feasibility was made by either of the two congressmen who wrote to explain changes made by the House-Senate conference bill.[23] The only comments on "feasibility" were made by Senator Peter Dominick (R., Colorado), who introduced the language relating to standards for toxic substances. In defending the language which he proposed (and which was later adopted), he stated:

> What we were trying to do in the bill—unfortunately, we did not have the proper wording or the proper drafting—was to say that when we are dealing with toxic agents or physical agents, we ought to take such steps as are feasible and practical to provide an atmosphere within which a person's health or safety would not be affected. Unfortunately, we had language providing that anyone would be assured that no one would have a hazard. . . .[24]

[23] Bureau of National Affairs, *Job Safety and Health Act*, pp. 287-293.
[24] Ibid., p. 298.

The synonymous use of "feasible" and "practical" in Senator Dominick's statement has been echoed in the major judicial decision on "feasibility," where the court of appeals held that

> practical considerations can temper protective requirements. Congress does not appear to have intended to protect employees by putting their employers out of business—either by requiring protective devices unavailable under existing technology or by making financial viability generally impossible.[25]

The court went on to argue that a standard could be economically feasible and still be burdensome to employers—even to the point of putting some out of business. However, as such effects become more widespread, the court argued, the question of economic feasibility becomes more germane.

Similar issues arise in considering the safety and health mandate of the "general duty" clause. One scholar points out that the requirement to furnish employment which is "free from recognized hazards that are causing or likely to cause death or serious physical harm" means that absolute protection must be provided against recognized hazards likely to cause physical harm.[26] He argues that the unqualified language—rather than the words "reasonably free" or "likely to cause an unreasonable risk of death"—indicates that Congress did not intend to permit the balancing of risks against the costs of removing them that is allowed in negligence cases. Nevertheless, the landmark judicial decision did introduce economic factors into the general duty requirement. Essentially, the court held that a hazard must be preventable to be "recognized" and that a hazard is not "preventable" if it requires procedures "so expensive that safety experts would substantially concur in thinking the methods unfeasible." [27]

The concept of economic feasibility as a qualification to the mandate for absolute safety would appear to encompass only the most extreme kind of costs—those so large as to put significant portions of entire industries out of business. The rulings of the Occupational Safety and Health Review Commission have been

[25] Industrial Union Department, AFL-CIO v. Hodgson, 1 OSHC 1639, April 15, 1974.

[26] Miller, "Occupational Safety and Health Act of 1970 and the Law of Torts," p. 627.

[27] National Realty and Construction Company, Inc. v. Occupational Safety and Health Review Commission, 1 OSHC 1422, December 13, 1973.

consistent with this interpretation. The commission has time and again ruled that the fact that compliance with a standard is costly and impractical is no defense against a violation. In one prominent case, the employer argued that the installation of safety nets was impractical because of the time and effort to install them compared to the brief time the workers would be exposed to danger. The commission held: "The time and cost involved must be considered inconsequential when compared to the death or serious injury of a workman. . . . The employer's witness conceded that the installation of a net was possible. A violation of the standard is established." [28]

Thus, while the safety and health mandate under the Occupational Safety and Health Act has not been interpreted as absolute, it certainly does not seem to allow the balancing of the costs and benefits of hazard reduction except in the most extreme cases. In contrast to this congressional and judicial safety and health mandate is the desire of the President to assess the benefits and costs of increased safety. President Ford has contended: "The question is not whether we want to do something about noise and safety—but, whether making changes in our regulations would make sense in terms of the cost added and benefits gained." [29] To the above purpose, he has asked OSHA, among other agencies, to evaluate the inflationary impact of its standards. Indeed, OSHA has specifically rejected a very stringent noise standard, despite the hearing loss it would save, because of the cost involved in complying with the standard. (See Chapter III for a more complete description and analysis of the issues involved in the noise standard.)

Issues for Further Consideration

The discussion in this chapter raises a number of issues which merit intensive analysis. Just how much safety and health a society should try to provide is the question of fundamental importance, and this question is the focus of Chapters II and III. Other issues, also dealt with there, are (1) the conditions under which the government must act to provide the "right" amount of

[28] Secretary of Labor v. Universal Steel Erectors of Kentucky, Inc., 1 OSHC 3291, January 28, 1974. For other cases with similar rulings, see Secretary of Labor v. Intermountain Block and Pipe Corporation, 1 OSHC 3145, June 23, 1972, and Secretary of Labor v. Underhill Construction Corporation, 2 OSHC 1556, January 31, 1975.

[29] Bureau of National Affairs, *OSH Reporter: Current Report*, May 1, 1975, p. 1559.

worker protection, (2) the guidelines and procedures to be followed by the government in promulgating the standards consistent with achieving the general good, and (3) the contrast between the congressional and judicial safety mandate (as well as OSHA's actions), on the one hand, and the theoretically defensible norms developed, on the other.

Chapter IV deals with OSHA's enforcement program, examining both its impact in theory and whether OSHA inspections are indeed reducing injury rates. Chapter V suggests alternative approaches to the goal of improving health and safety among employees and makes some recommendations pertinent to the occupational safety and health program.

CHAPTER II

THE SOCIAL GOALS OF AN OCCUPATIONAL SAFETY AND HEALTH PROGRAM

"I can't believe that!" said Alice.

"Can't you?" the Queen said in a pitying tone. "Try again: draw a deep breath and shut your eyes."

Alice laughed. "There's no use trying," she said: "One can't believe impossible things."

"I daresay you haven't had much practice," said the Queen.

Through the Looking-Glass
and What Alice Found There

The safety and health mandate under the Occupational Safety and Health Act has been shown to be virtually unqualified: only in the event that almost an entire industry would have to close down would the courts rule that a technically possible hazard abatement program is "unfeasible." Is the goal of near-absolute safety socially defensible in a society seeking to advance the general welfare? Just how much safety is "enough" in our society? Is it being provided? These questions cannot be easily answered, nor should an answer be attempted without reference to an explicit theory of social welfare. The purpose of this chapter is to sketch such a theory, which is then used (1) to suggest the conditions under which governmental safety and health programs would be required to advance the general good, (2) to consider the need for such programs in the U.S. economy, and (3) to establish some rules which can be used to guide governmental decisions in the safety and health area. We begin with a fable.

A Safety Fable

In the oral tradition kept alive by some economists there exists a fable about an unknown—perhaps lost—kingdom in which there was no need for the government to institute an occupational safety and health program. The intriguing aspect of this fable is that, in this kingdom, selfish trolls owned and operated all the businesses. These trolls were thoroughly self-serving creatures who cared not at all about the safety, per se, of the gnomes who worked for them. The only thing the trolls did care about was lining their pockets with as much gold and silver as possible.

The gnomes were frightened by the motives of the trolls, and angered by the risks they faced on their jobs. So they petitioned the good king, who ruled the land wisely, crying, "Your Highness! The trolls care not for our safety at work. They care only for themselves and the gold and silver they have. Please help us improve the quality of our lives!" The king appointed a Royal Commission on Work Safety to investigate these charges, and six months later (remember, this is a fable) the commission delivered its report.

The report confirmed that trolls were selfish profit maximizers who never even felt sad when a gnome was injured or killed on the job. The report further stated that trolls, though unfeeling, did provide some safety for their employees; however, they only reduced hazards if it was profitable to do so. Injuries, it seems, were costly to the trolls. Other gnomes stopped work to help out the victim, so production was lost. A replacement had to be trained to fill in for the injured gnome, and this the trolls found costly. Often damage to the troll's machinery accompanied a work injury. And, of most importance, trolls with the most dangerous factories had to pay higher wages for the same gnomes employed by others. The reasons these "risk premiums" existed were listed by the commission as: (1) the gnomes knew the risks they faced in each factory, (2) not all trolls found it profitable to offer only dangerous work, and (3) gnomes had a wide choice of jobs. Therefore, in order for a troll offering relatively dangerous work to attract enough gnomes, he had to pay a wage rate high enough to compensate gnomes for the increased risks they faced in his factory. Gnomes insufficiently compensated for the higher risk took jobs in safer factories.

The above costs provided incentives for the trolls to improve safety, but improving safety itself consumed resources. The trolls,

in trying to produce at minimum cost, provided enough safety so that the sum of injury costs and injury prevention costs were as small as possible. This kept prices down, but it did mean that injury rates were different in every factory, depending on the costs of injuries and their prevention.

The report strengthened the will of the gnomes to demand more safety. They petitioned the king, saying, "The Royal Commission has confirmed what we told you. Trolls only provide safety when it is profitable. Economic needs cannot be allowed to prevail over gnome needs, and we beseech you to force the trolls to eliminate all hazards so that no gnome need face danger in the factory again!" The kindly king agreed, and an order banning all conceivable occupational hazards was issued. "Long live the king," shouted the gnomes. "Long live the gnomes," shouted the king in return.

Trolls everywhere were alarmed. Trolls building and repairing bridges (troll bridges, of course), for example, could not even begin to reduce hazards to zero. Bridge building and repairing therefore stopped. Trolls who built houses found it was possible to reduce all hazards, but it was not profitable to do so at prevailing prices. (After all, if it had been profitable to do so, it would already have been done.) Housing prices were increased, and some trolls left the construction business and invested their funds in royal bonds. Only industries where hazards had already been eliminated before the decree were unaffected by the phenomena of rising prices, business failures, and unemployment. Trolls were not merely absorbing the extra costs of safety in their profits, but passing these costs on to consumers.

Gnomes were numb with surprise. Their greater safety was being bought at the expense of fewer houses and bridges. How were they to live? How were they to visit their relatives if bridges could not be built or repaired? What had happened was not at all what they had expected, and they were confused. Although most unemployed gnomes eventually found work in factories making safety equipment, this equipment could not be consumed directly. There was more "safety" being produced now, but fewer other things.

Lack of open bridges and the shortage and expense of housing particularly bothered the gnomes. Their desire to travel was so strong and their loss of happiness so great when bridges were closed that they took to swimming across the rivers on their weekend travels. Even though some drowned, and even though

every gnome knew he was taking a chance, still gnomes kept on swimming. Likewise, each gnome wanting a house seriously considered building it himself. More and more gnomes built their own homes, and every Monday the factories would buzz with the news of gnomes who had been injured on the weekend building their own homes. Yet every conversation would end with someone saying, "What are you going to do, with housing prices so high? The average gnome has to take chances just to maintain the standard of living he used to have."

Soon the king became alarmed at the number of weekend injuries and deaths. He called the gnomes together and asked, "Why is it, when I gave you absolute safety on the job, you chose to take more risks on the weekends?" The gnomes replied, "Sire! It is true we are safer at work, but the things we must buy are now much more expensive. We cannot even use our footbridges any longer. To maintain our standard of living we must do more for ourselves, despite the risks!"

Becoming red with anger, the king shouted, "You have played me for the fool! I reduce hazards in your factories to improve your lives, and you go out and choose to take more risks off your jobs. You even have the gall to complain that you are not as happy as before!" Building to a towering, irrational rage, he screamed, "I now ban all unsafe acts and conditions off the job too. No more swimming! No more house building by individual gnomes! No more sports! Elevators are not ever to be used again! All power mowers are forever banned! If you want the maximum safety technologically available, that is what I shall force you to have!!!"

The gnomes fell to their knees. "Please, Sire! Do not be so cruel. Our mistake was one of ignorance. We did not realize that safety was so costly in terms of what we must give up to get it, or that the benefits were limited. We have been taught by our teachers that the value of a gnome life is infinite, but we now see that we do not act as if we value our own lives at infinity. We admit we do freely take more than the minimum chances with our lives and safety in order to achieve greater happiness. Please let us take these chances again!"

His heart softened by the honest contrition of the gnomes, the king said, "We have all learned a valuable lesson. Safety has both costs and benefits which affect the lives of gnomes everywhere. The costs of better safety are measured by the happiness gnomes must give up by having fewer and more expensive consumer goods and services available. The benefits of greater safety

are mostly made up of the greater happiness gnomes achieve by facing fewer risks on the job. We must find a way to balance these costs and benefits against each other."

At this point a troll with a gruff voice spoke up, "The trolls are the ones best able to balance these costs! We are aware of the costs of injuries and their abatement in each of our factories, because we deal directly with workers and safety experts. We know that if injuries are reduced, we can pay our gnomes less and they will be at least as happy as before. Suppose that by reducing a certain risk we can cut their wages $90 a year—but no more, or they will quit. We then compare this saving to the net cost of achieving this risk reduction. If the net cost (cost of safety equipment, net of gains from fewer production losses, and so on) comes to $100, say, we will not improve safety."

"Boo-oo-oo," screamed the gnomes. "Let me finish," roared the troll. "Even the kind king would not want to reduce injuries in the situation I just described. Safety resources cost $100 because gnomes would obtain at least $100 worth of pleasure from the consumer goods these resources could have been made into. If we use resources which could give $100 worth of satisfaction in a way which only increases the happiness of gnomes by the equivalent of $90, the overall happiness of gnomes is being reduced."

"But how do you know we would get only $90 of happiness out of the reduced risks?" the gnomes jeered. The troll, growing weary, replied, "Because if the increased safety were worth more to you, each of you would be willing to take a pay cut larger than $90. Conversely, to accept the risk you would each require more than $90 in added compensation. Your actions reveal how much you value increased safety."

The gnomes were stunned by the faultless logic of the troll, and amazed he had talked in terms of happiness and not just dollars. The king, thoroughly convinced, called out to the quiet assembly before him, "Royal decrees about safety are hereby abolished, and I will take no further action in this area of your lives except to ensure that you are aware of the risks you take and are mobile enough to avoid the risks you do not wish to accept." And they lived as happily as possible, on their limited resources, ever after.

Some Morals of the Story. Our fable illustrates several important points about safety and health. Perhaps the most obvious is that

the goal of a minimum-risk work environment would probably be so costly to achieve that society would be better off (happier) by allowing some risks to exist. Reducing risks is "costly" precisely because resources (people and materials) which could have been used to produce goods and services—and therefore happiness—are devoted to the reduction of risk. While at the present time the devotion of more resources to increasing health and safety may well generate more happiness on balance than is being generated now, it is difficult to imagine a society willing to devote so many of its resources to safety and health that the bare minimum of risk is achieved. Certainly in areas of our lives where we have free choice about risk assumption—unconstrained by pressures from an employer, for example—we gamble with our safety on a regular basis. We drive cars, often without seat belts; we fly in airplanes; we smoke; we ride elevators; we ski—and so on. In each of these activities we are making a choice to gamble with our health and safety precisely because the act giving rise to the risk is more pleasureable than its riskless (or less risky) alternative. Our own health and safety is not worth an infinite amount, even to ourselves.

A second point to be drawn from the fable is that *safety and health decisions should result from a balancing of costs and benefits flowing from the decisions.* There is nothing immoral in considering safety or health in a benefit-cost framework as long as all costs and benefits are properly accounted for. Indeed, because the goal of benefit-cost analysis is to decide if human welfare—as judged by the people themselves—will be enhanced by a particular decision, discussion of safety and health issues in these terms is profoundly moral. If achieving a certain degree of safety on the job is going to cost $20 billion—even after netting out the benefits of increased productivity, medical cost savings and so on—it means that resources which generate at least $20 billion in happiness are going to be spent on safety. Put another way, a government requiring a $20 billion expenditure on safety is forcing consumers to give up resources on which they were willing to spend $20 billion (directly or indirectly) precisely because these resources yielded them an equivalent amount in happiness. (If the resources had yielded less happiness, consumers or producers would not have valued them so highly.) Society must insist that this $20 billion expenditure on safety generate at least this same amount of happiness; if it does not, society has "too much" safety—that is, less safety would yield greater overall happiness.

Conversely, if the $20 billion program generates more than that in benefits, this would indicate society had "too little" safety before.

How can we be sure that benefits in this case are worth at least $20 billion? The issue is more tractable conceptually than it is empirically. In the perfectly functioning and knowledgeable society of the fable, the benefits of a safety program could be inferred from the structure of wages. If workers in a plant complying with the governmental safety standards were willing to work for a total of $25 billion less than similar workers in the more dangerous factories, we could infer that they value the government-induced safety at $25 billion. If the increased safety were valued less, they would not be willing to work for $25 billion less just to obtain the safer environment. However, the practical difficulties in measuring the benefits of added safety are immense, because we can by no means be sure that "risk differentials" in wages exist or that workers are so knowledgeable and mobile that these differentials accurately reflect their true preferences about added safety.

Notwithstanding these practical difficulties, at this juncture the second point of the fable still has three important implications for policy discussions: (1) *There is nothing inherently immoral about discussing safety in terms of its costs and benefits.* (2) Given a certain objective in terms of injury or disease reduction, *society should choose the least costly method for achieving that objective.* This decision rule stems not from a desire to protect the profits of businessmen, but from the realization that resources are limited and must be conserved if the greatest amount of human welfare is to be attained. (3) *There is no justification for seeking equal levels of risk in every occupation, factory, or industry,* because the costs of reducing risks are likely to differ with techniques of production. The costs and benefits of added safety must ideally be balanced in every situation. Forcing the same level of safety on every plant almost certainly guarantees that there will be "too little" safety in some places and "too much" in others, and in each of these plants there would be a potential for increasing societal welfare by a proper balancing of benefits and costs of added (or reduced) safety.

The third point to be drawn from the fable is that, *under certain stringent conditions, the private marketplace will make the same decisions about safety and health as would a benign government.* The conditions under which the proper safety decisions will be made by privately owned businesses are that all costs

and benefits of the added safety are borne by the businesses. If the true social costs and benefits of safety are not reflected in the prices, taxes, or wages faced by private producers, they will not be induced to make "correct" decisions. Suppose, for example, a certain safety objective which can be attained at a cost of $20 billion has $25 billion in benefits, but private producers (for one reason or another) only save $15 billion. The private sector would not undertake the program, and the government would have to step in to ensure that the correct decision (that is, undertaking the program) were made. Thus, the government must intervene in the safety and health area if the private market can be shown, or can reasonably be presumed, to have failed to make the correct decision.

The remainder of this chapter is devoted to a consideration of the need for the Occupational Safety and Health Act and a general review of the method by which OSHA can determine the desirability of its decisions.

Are We Producing "Enough" Safety and Health?

As the fable points out, the "production" of increased safety and health is costly because it uses resources that can also be used to increase human welfare in other ways. Devoting more resources to occupational safety and health only makes sense if those resources will generate greater additions to human welfare when used for safety and health than when used otherwise. In a society which values individual freedom, people themselves should be the judge of what alternative allocation of resources makes them happiest. The decision rule which should guide safety and health policies is therefore exactly the same as the one that is used to decide on how many color television sets and pounds of beef should be produced: are the people who derive benefits from the product willing to pay for it? [1] If not, they are signaling that they

[1] This decision rule will lead to different allocations of resources, given different distributions of income. If society is collectively unhappy with the level of income or range of job choices facing some of its members, there are welfare, antidiscrimination, and job training programs that can be used to change incomes and job choices available. The Occupational Safety and Health Act would be highly inefficient as a means for this kind of change. Some of the most dangerous jobs are held by the highest-paid workers (construction, coal mining), while not all low-paid workers are in high-risk jobs (hospitals, laundries and retail stores all have below-average injury rates). The Occupational Safety and Health Act is therefore best viewed as an attempt to correct an allocation of resources problem, rather than to correct a distribution of income problem.

would rather spend their income on other things—that the product in question is not worth the cost to them.

In the fable, the private market worked well in allocating the "proper" amount of resources to job safety and health. Employers acted as middlemen between fully informed, mobile workers and the producers of safety equipment. Safety was essentially "sold" to employees through the wage rate; reducing risks meant lower wages and increasing risks meant higher wages, other things being equal. In the fable, then, employees really did pay for increased safety, and employers would stop increasing safety when employees were not willing to pay the costs—that is, when the employers experienced trouble keeping employees at the reduced wage and reduced risk levels.

The existence of a perfectly functioning market for safety and health in the fable does not, of course, imply that such a market exists in the United States today. In particular, one wonders (a) whether employers do in fact "supply" job safety and health as they do other products, and (b) whether wage premiums for the assumption of on-the-job risk do in fact exist. If the answer to either (a) or (b) is negative—or if there is reason to believe that wage premiums are not fully compensating—then we cannot have confidence that the private marketplace is making the correct safety and health decisions. The government, in such a case, might well intervene with some kind of safety and health program in order to improve the general level of well-being in the country.

The Supply of Job Safety and Health. Can it be demonstrated that occupational safety and health are supplied by employers when there are economic incentives (a "willingness to pay") for their production? To test the hypothesis that the level of on-the-job risk is responsive to market incentives, let us begin with the notion that the employer has a choice. He can accept higher injury rates and pay their associated costs (replacement of the victim, machine damage and perhaps wage premiums to workers), or he can purchase such safety resources as protective clothing, machine guarding and training sessions in order to reduce injuries (which is to say, produce safety). The employer will continue to purchase safety resources until the added savings from injury reduction are just equal to the cost of the resources necessary to generate the reduction. At what point the employer stops producing safety depends on the costs of injury reduction and the savings such a reduction can generate for the employer. Given the same degree

of inherent technological risk, we should thus expect to find that injury rates are lowest in firms or industries where injuries are most costly and their eradication is relatively inexpensive.

A test of the implications of this "market" model of job risks has been made using data on manufacturing injury rates; lack of data has prevented the test from being extended to other industries or to the area of job-related disease. The results of this limited test of the model do suggest, however, that manufacturing industries where the economic incentives for injury reduction are most strong have the lowest injury rates, other things being equal (see Appendix B for this test and the results). Injury rate differences across manufacturing industries are neither random nor solely a reflection of inherent technological hazards; instead, employers do choose to "supply" safety when it pays. While by no means conclusive evidence that the "supply" of safety and health is everywhere responsive to economic incentives, the findings suggest that job safety and health are provided on much the same basis as other goods and services. If this is so, a decision about government intervention must rest on evidence on how well the job safety and health market functions.

The Existence of Risk Premiums. Many of the costs of industrial injuries are borne directly by the employer: production is lost, employee morale is affected, reports have to be filed, and so on. In most cases of serious injury, however, it is the worker who loses the most. Unless employees can somehow transfer the costs they bear when injured to the employer, the employer will produce too little safety. Put differently, employers are "middlemen" between the ultimate consumers of safety (their employees) and the producers of it (the people who produce safety equipment, for example). As "middlemen," they must bear the same costs and reap the same benefits as the primary producers and consumers; otherwise they will not make the same decision as the primary parties would have made had they contracted directly with each other. In particular, if the costs (benefits) of reduced (increased) safety, as evaluated by the employees, do not fully accrue to their employers, the employers will not produce the amount of safety for which their workers are "willing to pay." They will, instead, produce "too little."

There are three ways for employees to transfer their injury costs to employers. One way is to allow injured employees to sue their employers under negligence law (if injured as a result

of a hazard). This method, however, is precluded under the "no-fault" approach of Workers' Compensation law, which covers most jobs in our society. The second method—that taken by Workers' Compensation—is to provide post-injury compensation to employees which the employer must insure against. In practice, this approach does not completely transfer all injury costs to employers, because (a) Workers' Compensation fails to replace the full amount of lost income of the injured worker,[2] and (b) the insurance premium is not closely tied to injury experience in the vast majority of firms.[3] This latter problem suggests that even if injured workers were fully compensated, employers would not bear the full cost (nor reap the full return) of an increase (decrease) in their injury rate. Hence, the Workers' Compensation system itself works to some extent in the direction of inducing "too many" injuries.

To the extent that workers do not receive full post-injury compensation, a third approach must be relied upon to transfer injury costs to the employer: risk premiums imbedded in the wage rate. If the labor market functions properly, so that employees know the risks they face and can freely choose among a variety of jobs with different risks, then these "compensating premiums" will arise naturally. Employers offering dangerous jobs will have to offer higher wages in order to attract workers; otherwise these workers would prefer to take safe and pleasant jobs.

Tests for the existence of risk premiums cannot be accomplished by simply correlating wages with injury rates, because tests of this sort ignore other factors which influence wages (education, race, sex, experience, unions, and so on). The real question is whether, after controlling for these other influences on wages, it can be shown that wage rates are higher in high-risk jobs. Because of the lack of data, tests for "compensating premiums" have been limited to work injuries (mainly fatalities) rather than disease, but each of four studies has found that such

[2] In 1972, thirty-two of the fifty states had maximum weekly benefits for temporary total disability less than 60 percent of the average weekly wage. See National Commission on State Workmen's Compensation Laws, *Report* (Washington, D. C., July 1972), p. 61.

[3] The responsiveness of insurance premiums rises with firm size. Even in firms with 1,000 employees, however, a 10 percent rise in injuries would only induce a 3 percent rise in premiums. Only when firm size reaches around 3,000 is the premium fully responsive to the injury rate. See Louise Russell, "Pricing Industrial Accidents," *Supplemental Studies for the National Commission on State Workmen's Compensation Laws*, vol. 3 (Washington, D. C., 1973), p. 35.

wage premiums exist. Two studies found premiums related to occupation-specific risks,[4] while my own studies have found premiums related to industry-wide risks of injury-related death. The later of my two studies (which are summarized in Appendix B) suggests that in manufacturing industries where the yearly death rate is 16 per 100,000 workers, for example, employees receive approximately 1.5 percent more per year (on the average) than do employees of comparable skills in manufacturing industries which have the average rate of 8 deaths per 100,000 workers.

The Adequacy of Risk Premiums. The finding that compensating premiums (particularly for risk of death) do exist and that employers do supply safety in response to incentives suggests that there is a private market for safety which functions more or less like the market in the fable. The justification for government intervention in the area of job safety and health must, then, rely on the presumption that this market does not function perfectly. For example, one might argue that risk premiums may well exist, but that they are not fully compensating. Unfortunately, because so many injury-related losses are of a psychic nature ("pain and suffering") we cannot begin to tell if the wage premiums are in fact fully compensating. We must, instead, base our decision about government intervention on presumptive arguments on whether workers are (a) well-informed of the true risks they face, and (b) mobile enough to avoid risks for which they do not feel fully compensated.

The strongest presumptive case for government intervention can be made in the area of occupational disease, where a lack of data prevents almost any analysis. This lack of data arises from the fact that many occupationally related diseases take years to develop, are difficult to trace to an occupational cause, and affect employees to different degrees. For example, asbestos-related cancer typically takes thirty years to develop,[5] while beryllium-related disease may not appear for ten years after the last exposure

[4] Robert E. B. Lucas, "Working Conditions, Wage Rates, and Human Capital: A Hedonic Study" (Ph.D. diss., Massachusetts Institute of Technology, October 1972), and R. Thaler and S. Rosen, "The Value of Saving a Life: Evidence from the Labor Market," Paper presented at the National Bureau of Economic Research Conference, Washington, D. C., November 30, 1973.

[5] Russell Settle, "Benefits and Costs of the Federal Asbestos Standard," Paper presented at a Department of Labor Conference on Evaluating the Effects of the Occupational Safety and Health Program, Annapolis, Maryland, March 18-19, 1975, p. 15.

to the dust.[6] Only 2 percent of coal miners with under ten years of experience have black lung disease, while 21 percent of those with more than thirty years of experience have it.[7] The long latency periods, the number of toxic chemicals (some 25,000 industrial chemicals are considered toxic), and the interaction with nonindustrial hazards—such as cigarette smoke—combine to make causal linkages difficult to identify and to make workers susceptible to misinformation. Asbestos workers, for example, were told that they were at risk only if they smoked, even though company doctors had, in fact, discovered all workers were at risk (with smokers facing the highest risks).[8] The difficulties in producing and disseminating timely and accurate information would appear to make the case for government intervention compelling in the case of occupational health.

The case for intervention is not as compelling in the case of occupational injury, because workers can determine—independent of employer-provided information—when injuries have occurred or when hazards are present. They will either see them or hear about them, and although it may take some time before they learn of the true risks they face, they are less susceptible to biased information from a deceptive employer. With work safety, the question is one of mobility.

It is important to understand that not everyone need be mobile in order for there to be fully compensating differentials, so long as the fringe of workers who are mobile are as well informed and have the same attitudes about risks as do less mobile workers. The problem is that the most mobile workers within an industry or occupation are the young or recently hired.[9] These workers, because of their inexperience, are not well informed about injury risks: in particular, they may tend to overestimate the average risk because they themselves are much more likely to be injured than are other employees.[10] On the other hand, young workers may be less averse to risks than are older workers

[6] Rachel Scott, *Muscle and Blood* (New York: E. P. Dutton & Co., Inc., 1974), p. 16.

[7] U.S. Department of Labor, Special Projects Staff, unpublished data pertaining to the Black Lung Benefits Program.

[8] Paul Brodeur, *Expendable Americans* (New York: The Viking Press, 1974), p. 80.

[9] Edward Kalachek, *Labor Markets and Unemployment* (Belmont, Calif.: Wadsworth Publishing Company, Inc., 1973), p. 52.

[10] Walter Oi, "On the Economics of Industrial Safety," *Law and Contemporary Problems*, Summer-Autumn 1974, pp. 683-685.

with families, and therefore may demand less compensation for facing the same risks. The most mobile workers are thus not representative of the remainder of workers. To the extent they overestimate "average" risk they demand a greater compensating premium than would the less mobile workers; to the extent they are not as bothered by risks, they demand a smaller premium than would other workers. If compensating premiums result only from the behavior of this mobile fringe, work safety may well be either over- or under-provided.

The better-informed established workers, of course, are not completely immobile. Nevertheless, pension plans, seniority rights, employer-specific skills and advancing age all combine to make job-switching costly. These employees will not be completely responsive to changes in hazards; because of this, if it is only mobility that will create compensating premiums for this group, one would not expect the premiums to be fully compensating.

In many cases, however, trained and experienced workers are relatively costly to replace if they quit. This fact suggests that these employees need not actually quit to signal their desire for a higher wage if risks rise; the threat of quitting (or striking) is enough to make employers attentive to worker preferences. Thus, the lack of mobility among experienced workers need not be a deterrent to the growth of compensating wage premiums. It is impossible to say whether, aside from the defects introduced by Workers' Compensation premiums, the market succeeds or fails in transferring to their employers the costs of injuries to experienced workers.

What evidence there is on job safety suggests that private employers have pushed injury reduction to the point where those injuries which remain are relatively costly to eliminate. My estimates (see Chapter V and Appendix B) imply that before OSHA only around 10 percent of lost-workday injuries could have been eliminated by employer expenditures of as little as $2,000 per injury. If we assume that hazards are eliminated in ascending order of abatement cost, this estimate—which is admittedly crude, but all we have at the moment—would indicate that employers were already supplying a good deal of safety without government intervention. While such evidence by no means implies that "a good deal" of safety is "enough," it does warrant caution in accepting the widespread belief that employers seriously underprovide job safety.

These arguments about the provision of job safety and health by employers imply that the gains to society will almost certainly be larger if the Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health concentrate their scarce resources on stimulating occupational health, while moving rather cautiously in the area of job safety. To some extent, federal resources have been concentrated primarily on health. Three of the four standards passed under the permanent procedures have been health standards, while all but one of the more than twenty studies the National Institute for Occupational Safety and Health has worked on for the purpose of recommending standards have related to occupational health.[11]

On the other hand, OSHA has been much more vigorous in its safety inspection activities than it has in its health inspections. For support of this argument, let us consider OSHA's performance under its Target Health Hazard Program, which is aimed at enforcing the standards relating to asbestos, lead, silica, cotton dust, and carbon monoxide. In the last half of 1972 (the first period for which data are available) only 7 percent of all federal inspections were conducted under the Target Health Hazard Program, while 35 percent of all federal inspections were conducted in the target program aimed at five high-injury industries.[12] In fiscal year 1974, the comparable figures are 3 percent and 12 percent, respectively.[13] Thus, OSHA appears to be allocating about four or five times as many resources to its target safety program as it is to its target health program. The result is that, while the target safety program was approaching full coverage of its population by the end of 1972, the target health hazard was most likely covering about 5 percent of its population each year.[14] The arguments of this section, as well as the findings in Chapter IV on the effectiveness of OSHA's target safety program, suggest that this emphasis on safety is ill-considered. Society is likely to derive much larger gains from a program emphasizing occupational

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[11] See Bureau of National Affairs, *OSH Reporter: Current Report*, May 10, 1973, p. 1440, and October 24, 1974, p. 593.

[12] Office of the President, *The President's Report on Occupational Safety and Health*, House Document No. 93-65 (Washington, D. C.: U.S. Government Printing Office, 1973), p. 36.

[13] U.S. Department of Labor, Occupational Safety and Health Administration, "Monitoring Quality and Quantity Performance of the Field Compliance Staff," unpublished report, August 1974, pp. 15-16.

[14] Page and Munsing, "Occupational Health and the Federal Government," pp. 665-666.

health than from a program emphasizing occupational safety, because the private market for occupational health functions less effectively than the private market for occupational safety.

An argument that the government is justified in developing a safety or health program does not necessarily indicate the form or extent of the program. Alternatives to the standards-setting form of intervention will be discussed in Chapter V. The procedures to be used in determining the extent of the program are discussed in the following section and illustrated in Chapter III.

Benefit-Cost Studies

Benefit-cost studies are the tools used to determine whether the increases in human welfare (the benefits) which arise from compliance with a particular standard are larger than the human welfare foregone because resources which could be used for other goods and services are devoted instead to increased safety and health (the costs). Both conceptually and operationally, the question studies of this sort try to answer is whether the workers benefitting from the increased safety would be willing to pay for the program. Of course, determining "willingness to pay" is not a problem when, in fact, beneficiaries do pay for the goods or services they receive; the willingness is apparent from their behavior. (If the resources required to color a television image produced more happiness when used in other ways, people would not be willing to pay the extra costs of a color television.) It is in the case where the beneficiaries do not directly pay for a program that their "willingness to pay" must be imputed through a benefit-cost study. The estimation of this "willingness to pay" in situations which involve death or permanent impairment strikes most people as morally objectionable, and it is to this problem that the analysis which follows is devoted.

While each of us regards life as having inestimable value, none devotes all his resources to preserving life and limb. Indeed, we all take more than the bare minimum of chances with our life and limb. We smoke cigarettes, mow our lawns with powerful and dangerous (not to mention noisy) machines, rebel at the mandatory use of seat belts, ride in cars and airplanes, overeat, and often only see doctors when symptoms of disease are well-advanced. In other words, from our behavior one can infer that there are financial and psychic limits beyond which we are

unwilling to go to protect our own life and limb.[15] Benefit-cost analyses must try to estimate these limits in order to accomplish their purpose of simulating the decisions which individuals would have made had the safety and health market been functioning properly.

It is absolutely crucial, in developing estimates of the willingness to pay for increased safety and health, that the willingness of the people at risk be counted. It is not what Smith is willing to pay to reduce the risk of Jones's death that is important, but what Jones is willing to pay.[16] After all, Jones is the beneficiary of the safety and health program.

Since Jones loses more than an income if he is killed or disabled, to estimate a willingness to pay based on one's income alone will vastly understate the willingness of the people at risk. Thus, to conclude that workers with discounted lifetime earnings of $100,000 would be only willing to pay $8 to have the risk of death or total disability reduced from 16 to 8 per 100,000 workers would be an unconscionable assertion that people are only concerned with money and that they would expect to bear no psychic losses from death or disability. Only when an attempt is made to infer, from the actual behavior of the people at risk, what they would be willing to pay can we begin to have confidence that we are not misstating their willingness.

Because people can be induced to take chances with their health or safety, we can in some cases derive estimates of how large such inducements need be to get the people to take a given chance. To illustrate this, let us recall that it was reported earlier how workers appear to require 1.5 percent more in yearly income (other things being equal) to accept jobs where the death rate is 16 per 100,000 rather than where it is 8 per 100,000. Thus, a worker earning $8,000 per year is willing to give up $120 to reduce his own chances of death from .00016 to .00008. We could

[15] Some argue that it is the irrationality of individuals—their "it can't happen to me" attitudes—that lead people to take more than the minimal chances with their lives and limbs. This view of the individual—as well as the views assuming people do know best for themselves—cannot be proven or disproven. However, almost all the major decisions in life are left to the individual in our society, under the explicit belief that individuals themselves should be allowed the freedom to choose among courses of action—a view inconsistent with the notion that people are irrational and must therefore be protected from themselves.

[16] Only in the case where Smith really cares about Jones, but Jones is either unaware of his concern or is insensitive to it, should Smith's willingness to pay be added to Jones's. Otherwise, Jones's willingness will reflect Smith's, and to include Smith's would be double-counting.

thus infer from their behavior that workers at risk would be each willing to pay roughly $120 a year for a government-induced safety program which reduced the yearly chances of death by a comparable magnitude.

Unfortunately, it is not always possible to estimate people's willingness to pay for risk reduction, and what evidence there is may be fragmentary or subject to statistical biases. Likewise, there may be conflicting estimates of "willingness to pay." In these cases, which are at this stage by far the majority, three alternative methods of presentation seem useful. First, one can knowingly use underestimates of the willingness to pay, and if the program costs are still less than the benefits one can then be certain the program is worthwhile. A benefit-cost study of OSHA's asbestos standard,[17] for example, used lost income from early mortality as a measure of workers' willingness to pay for asbestos-dust reduction to mandated levels. This procedure—as we noted above—clearly understates the value workers place on risk reduction. Nevertheless, the study demonstrated that even with downward-biased estimates of benefits, the asbestos-dust reduction program still appeared to be cost-beneficial.

Second, one could in some cases knowingly overstate benefits and test to see if the program looks undesirable. For example, a study of a machine-guarding standard might require unavailable estimates of how much people are willing to pay to reduce the risk of losing a finger. If, instead, an estimate of what people are willing to pay to reduce the risk of losing a hand were available and employed, and program costs still outweighed the benefits, then clearly the program would not be worthwhile.

Finally, in the indeterminate cases above, perhaps the best the analyst can do is calculate what people would have to be willing to pay in order to justify the program. This figure (or range of figures) can then be examined by policy makers to decide if they look "reasonable" or not, given what is known about human behavior in the relevant area. An example of this approach is provided in the next chapter.

One final word is in order on the general idea of cost-benefit studies in the safety and health area. Even if it is considered morally objectionable to quantify the benefits of a safety or health program in explicit terms, one cannot escape the fact that any decision about such a program implies a set of benefits. It is more honest and useful to quantify these benefits explicitly than it is

[17] Settle, "Benefits and Costs of the Federal Asbestos Standard."

to pretend one is "above" such a "dollars-and-cents" approach and then value the benefits implicitly. With the ideas of this chapter in mind we may turn, in the next chapter, to an example of the kind of analysis OSHA should employ in its standards-setting process.

Summary

This chapter has sketched a theory of social welfare that may be used to analyze the question how much safety and health our society should attempt to provide for its workers. This theory suggests the following general guidelines for OSHA policy making: (a) the goal of minimizing occupational risks is probably not socially desirable (as judged by the people themselves); (b) safety and health decisions should be made in a benefit-cost context; (c) OSHA should encourage the achievement of given safety and health goals at minimum cost; and (d) the goal of equalizing risks across occupations or industries is not necessarily consistent with the goal of providing for the general welfare.

The theory sketched in this chapter was also used to analyze the conditions under which the private market would fail to provide the "right" amount of safety and health. The chapter then reviewed evidence on the actual functioning of the labor market in the provision of safety and health: the supportable conclusion is that occupational health is probably seriously underprovided in this country, but that occupational safety cannot be presumed to fall far short of being "correctly" provided. The policy implications from this conclusion are that OSHA and NIOSH should concentrate their resources on health rather than on safety. Unfortunately, OSHA only partially focuses its efforts on health.

The chapter ended with a discussion of the estimation of safety and health benefits, including the options for such calculations when estimates of "willingness to pay" are fragmentary.

CHAPTER III

THE NOISE STANDARD: STANDARD-SETTING IN THEORY AND PRACTICE

An ounce of prevention is worth a pound of cure.

While Benjamin Franklin may have been correct in believing that reducing the probability of accidents is usually cheaper than dealing with their consequences, it has been argued in Chapter II that OSHA should not necessarily try to reduce the risks of occupational injury or disease to the technologically feasible minimum. Instead, OSHA should attempt to set its standards at that level of stringency for which the additional costs and benefits are roughly balanced. It is important, therefore, that the guidelines developed in Chapter II be both susceptible of use and actually employed in decisions made by OSHA.

OSHA has never conducted a benefit-cost study of any standard it has proposed, although one such study was performed outside of OSHA after the asbestos standard was promulgated and showed the standard to be helpful in promoting the general welfare.[1] In part, this absence of proper analysis has been the result of beliefs that reduced risks of injury or disease should not be treated as an economic commodity—a view which Chapter II attempted to dispel. Also, given the legislative mandate and judicial decisions, it is not clear that OSHA could legally justify a decision based on a weighing of costs and benefits. Nevertheless, benefit-cost analyses, it has been argued, are the only defensible tools by which to judge the social efficacy of any standards, and their lack of use in standard-setting is regrettable. The purpose of this chapter is to illustrate the practicality, insights

[1] Settle, "Benefits and Costs of the Federal Asbestos Standard."

and problems of benefit-cost analysis in the safety and health area by analyzing OSHA's decision on the noise standard.

A careful consideration of the decision concerning the limits on occupational noise is particularly interesting because it is the first standard to pass through OSHA's permanent standard-setting procedure to have a pervasive effect on industry. Because its impact will not be limited to just one industry or occupation, the noise standard is the most controversial one yet proposed. Indeed, the executive secretary of the AFL-CIO's standing committee on safety and health believes the debate on the noise standard to be a "battle of Gettysburg": "The debate will be between two philosophies—one stressing the costs of implementation, the other the health of workers—and . . . OSHA's ultimate decision will reveal how the Administration intends to enforce the law." [2]

Existing and Proposed Noise Standards

OSHA's original noise standard was passed under the interim procedures specified in the act. The standard limited the noise to which workers could be exposed (per eight-hour day) to 90 decibels (dBA). If noise levels were 95 dBA, workers could only be exposed for four hours and could then not be exposed to noise over 90 dBA the rest of the day. Workers could only be exposed to noise of 100 dBA for two hours, and impulse noise could not exceed 140 dBA. Engineering controls or worker job rotation had to be used, under the standard, to enable the firms to come into compliance; only if these measures were not feasible could personal protective equipment (such as earplugs or ear muffs) be used to reduce sound levels to which workers were exposed.[3]

On August 14, 1972, the National Institute for Occupational Safety and Health issued a criteria document which called for the eight-hour exposure to be limited to 85 dBA, the four-hour exposure to 90 dBA, and the two-hour exposure to 95 dBA. Impact noise, it was recommended, should not exceed 115 dBA.[4] The five dBA reduction in all but impulse noise levels may appear to be small, but it is not. Noise of 85 dBA, for example, has less than

[2] James W. Singer, "Network of Laws Rule Employer-Employee Relations," *National Journal Reports*, March 22, 1975, p. 439.

[3] *U.S. Code of Federal Regulations*, Title 29, Section 1910.95.

[4] U.S. Department of Health, Education and Welfare, National Institute of Occupational Safety and Health, "Occupational Exposure to Noise," 1972, Chapter I.

half of the energy, and sounds only 75 percent as loud to the ear, as noise of 90 dBA. NIOSH recommended the new standard to reduce the chances of workers' incurring noise-induced hearing loss.

OSHA commissioned an economic impact study to estimate the costs of compliance with the 90-decibel standard, which was not being completely enforced, and with the NIOSH alternative. This study estimated the costs of compliance, for manufacturing industries alone, at $13.5 billion and $31.6 billion for the two alternatives, respectively. This report was submitted in January 1974, and in October of that year OSHA proposed a standard which left the original exposure limits unchanged but had more detailed requirements on monitoring workers' hearing and testing for factory noise levels. OSHA's decision explicitly recognized the greater risk of hearing loss to which employees would be exposed, but argued that this reduced risk was not worth the added cost of the 85-decibel standard. OSHA's decision was not based on any study which attempted to estimate workers' willingness to pay for the reduced risks.

OSHA received over 800 comments on its proposed standard, and in December the Environmental Protection Agency (EPA) criticized OSHA's proposal, arguing that the noise exposure levels should be 85 dBA for eight hours, 88 for four hours, 91 for two hours, and so on. The Environmental Protection Agency recognized the difficulty of achieving this ideal in all industries, and one of its proposals to deal with this problem was to set industry-by-industry standards for noise.[5] OSHA rejected EPA's criticisms and suggestions, arguing that industry-specific standards would be inequitable by affording different levels of protection to different workers.[6] Hearings on the noise standard proposal were held in mid-1975.

OSHA's Decision: Some General Comments

The basic weakness in decision making on the noise standard has been the failure by OSHA and by its critics even to attempt to find out whether the beneficiaries of the program would be willing to pay its costs. The failure to think in terms of costs and benefits has meant that three major decisions have been made arbitrarily,

[5] Bureau of National Affairs, *OSH Reporter: Current Report*, December 18, 1974, pp. 884-891.

[6] Ibid., March 20, 1975, pp. 1398-1401.

concerning the important issues of (1) noise exposure levels, (2) industry-by-industry standards, and (3) the use of personal protective devices.

With respect to the setting of noise exposure levels, OSHA explicitly recognized it must "balance the factors of protection of employees, technology and cost," [7] but the agency—because it has not employed benefit-cost techniques—has never developed a balancing method. In fact, the entire debate on this far-reaching decision has been carried on without any fundamental agreement about the proper decision-making criteria. Data on noise exposure levels, hearing loss risks, and cost of compliance have been gathered, but no one, including OSHA, has attempted to quantify the benefits. An attempt at quantification will be illustrated in the next section of this chapter, but before moving on it will be useful to discuss the other two major aspects of the proposed standard on noise.

Industry-Specific Standards. OSHA's decision not to allow industry-by-industry noise limits evidently conflicts with the decision-making guidelines developed in Chapter II. There it was argued that if all industries are required to meet the same standard, despite differences in the costs and benefits of compliance, OSHA will almost surely allow some industries to have "too many" risks while forcing others to have "too few." The point is that striving to attain an equality of risk across industries is, in general, not consistent with the goal of improving social welfare (see Chapter II for the reasoning behind this assertion).

Because the idea of "equal opportunity for safe work" has some rhetorical appeal, it may be useful to expand briefly on the undesirability of the concept as a social goal. One reasonable interpretation of this goal is that all work will be required to entail a minimum risk of injury; that is, structural steel workers must face risks as small as those accepted by office clerks. The fact that people as consumers freely and almost universally take "unnecessary"—as well as different—levels of risk is enough to suggest the social undesirability of this goal.

Second, however, the "equal opportunity for safe work" idea is based on the fallacious notion that unequal risk implies unequal human happiness. The happiness one derives from a job is a function of the wage rate, job tasks, prestige, and so on, in addition to the risk of injury or disease. There is growing evidence

[7] Ibid., p. 1399.

that workers are compensated for the "bad" characteristics of their jobs, including the risk of injury-related death.[8] Some prefer added income to reduced risk, and these are the ones who wind up in the more dangerous jobs. To force these workers to take reduced risks at the expense of higher wages will make these workers feel worse off. A recent example of forced risk reduction in the nonwork area is the law which, in effect, required the compulsory use of automobile seat belts. While such a law tended to equalize the risk of death for people driving cars (at least cars of the same size and age), it is clear that a considerable group of people preferred taking higher risks to the bother, discomfort, or expense of mandatory seat belt use. The law was ultimately repealed, largely as a result of consumer pressure.

There are some situations, particularly situations involving occupational disease, where it has been argued that compensating wage premiums are not likely to exist. This situation, however, does not justify reducing all risks of disease across industries to some equalized (presumably low) level, because the costs of doing so are not equal. While industry-specific standards will mean that some people will be exposed to more risk than others, one need only observe the different responses of people to the announcement of a smoking-cancer link to be reminded that there are large interpersonal differences in the perceived costs and benefits of reducing the risk of disease. In cases where ignorance of risks has effectively prevented compensating premiums from existing, the government can best achieve a goal of equalizing human welfare by educating workers about the risks they face (as in the case of cigarette smoking) and helping them achieve—through portable pension plans, job retraining, relocation subsidies, and the like—enough mobility to leave jobs for which the risks are insufficiently compensated.

Personal Protective Equipment. Another issue which OSHA has decided without regard to benefit and cost analysis concerns the use of personal protective devices (ear plugs and ear muffs) to reduce noise. Both the original and proposed standards allow noise level reduction through the use of personal protective equipment only if reduction by technical or administrative means is not technically feasible. While OSHA maintains that the use of ear plugs is not hygienic and can result in the reduction of effective communication between employees (possibly leading to increased

[8] See footnote 4, Chapter II.

accidents), the decision to insist on engineering and administrative means of noise reduction was not made in an explicit benefit-cost context. It appears, therefore, that OSHA has arbitrarily ruled out what may be a much less costly means of reducing noise—even after accounting for the undesirable side effects of wearing ear protectors. It is interesting to note, in this regard, that a judge for the Occupational Safety and Health Review Commission ruled that OSHA had failed to demonstrate that a rational basis existed "for compelling the employer to quiet the machines, at great expense, when the employee can be protected by personal devices at relatively little cost." [9]

To argue that personal protective equipment should not be excluded as a means of achieving a *given* level of noise reduction does not imply, of course, that the given level of reduction is desirable or that ear plug use should be required. Indeed, it is clear that most workers would not be willing to pay for the personal equipment necessary to achieve a 30-decibel reduction in factory noise (a good set of individually molded ear plugs can reduce noise by that much). In 1968 Employers Insurance of Wausau surveyed 1,148 plants which issued ear protectors (along with warnings about hearing loss) to employees: the survey revealed that only a fifth of the plants maintained the program for longer than six months because of the difficulties of enforcing the use of such protectors by employees.[10] If employees are not willing to wear protectors given them by employers, obviously the inconvenience of wearing them outweighs the benefits (including the benefits of reduced chance of hearing loss), and they surely would not be willing to pay for these protectors. To force them to wear protectors in order to achieve a reduction in noise levels would clearly make the "beneficiaries" of the standard feel worse off.

If employees are generally not willing to pay the costs of protective equipment designed to reduce occupational noise to mandated levels, the question arises whether they would be willing to pay for the required noise reduction through use of engineering controls. Employee behavior related to this question cannot be directly observed, so the answer to this question cannot be obtained as easily as was the answer for personal protective equipment. One set of procedures for attempting an answer is illustrated in the next section, to which we may now turn.

[9] Bureau of National Affairs, *OSH Reporter: Current Report*, October 10, 1974, p. 530.

[10] "Fight against Noise on the Job—A Health Hazard You Can't See," *U.S. News & World Report*, May 26, 1975, p. 78.

The benefits of reduced noise most likely fall into two categories: the benefits of reduced risk of hearing loss and the benefits relating to the more pleasant work environment which results as noise is reduced. Workers should be willing to pay something to obtain these two goods. Most of the costs of noise reduction are related to the resources which must be devoted to the manufacture of noise shields, mufflers, acoustical tile, and so on; but society must also devote resources to enforcement of the standard, and the expense of compliance with the standard may cause some resources to be idled temporarily (plant shut-downs, layoffs, and so on). The quantification of these benefits and costs is discussed below.

Costs of the Two Proposals. OSHA commissioned a leading noise consulting firm—Bolt, Beranek and Newman—to estimate, among other things, the costs to industry of compliance with the 85-decibel standard and the 90-decibel standard (which was not being fully implemented). The firm confined its analysis to the manufacturing sector (including utilities), where it employed interviews, its own knowledge, and data on the numbers of particular kinds of machines to make industry-by-industry "best guesses" as to the costs of compliance. It considered the direct costs of machine enclosures, mufflers, quieter parts, building treatments, and personnel enclosures, while explicitly ignoring the costs of audiometric testing, lost production time during set-up, decreased productivity resulting from machine enclosure and the enforcement costs to achieve complete compliance (it may be noted that the benefit calculations below assume complete compliance). While the estimates presented are admittedly "best guesses," the study appears to be carefully done, was performed by experts in the field of noise abatement, and (if anything) probably understates the costs.[11] Not only are the indirect costs listed above not

[11] See Bolt, Beranek and Newman, "Impact of Noise Control at the Workplace," Report No. 2671 submitted to the U.S. Department of Labor, Occupational Safety and Health Administration, Office of Standards, January 1974. This report has been criticized because of its reliance on interviews with employers and its assumption that retrofit devices and machine enclosures will be used. (See Bureau of National Affairs, *OSH Reporter: Current Report*, July 10, 1975, pp. 185-186.) The first argument is that employers will overestimate costs of compliance because of their opposition to the new standard, while the second argument is that (as yet undeveloped) technological innovations will significantly reduce costs. Both arguments ignore the fact that Bolt,

quantified, but the cost estimates implicitly assume only *one-time* compliance costs. To the extent that noise abatement devices depreciate over time, the use of one-time compliance costs will result in an underestimate of the true costs to society over the relevant time horizon.

The study suggests that the costs of securing compliance with the present 90-decibel standard in manufacturing (including utilities) alone would be $13.5 billion. To comply with the 85-decibel standard would require that society devote $31.6 billion to noise abatement, on a one-time basis, in these industries.[12]

Benefits: More Pleasant Working Conditions. The link between occupational noise and permanent hearing loss is well established and will be discussed later. However, other adverse effects of noise—largely ignored in the debate—also exist. Noise interferes with interpersonal communications needed for normal work and personal relationships. In addition, loud noise is irritating to most people, although long-term psychological or physiological effects have not been convincingly demonstrated.[13] Because noise is so unpleasant to most people, employees—on this account alone—should be willing to pay something for quieter working conditions. Because there are no studies relating wage levels to noise exposure (other things held constant),[14] we must infer from other

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Beranek and Newman is a firm of noise control experts standing to gain from promulgation of a new standard; hence, its own incentives would be to bias costs downward if it decided to depart from objectivity. The second argument is speculative and overlooks the fact that many employers will find it cheaper to use retrofit devices than to replace an entire useful machine just to take advantage of a new noise control device.

[12] Bolt, Beranek and Newman, "Impact of Noise Control at the Workplace," pp. 15, 28.

[13] It has been shown experimentally, for example, that physiological reactions to sudden noise do exist but tend to subside with recurrent exposure to the same sound. (See National Institute for Occupational Safety and Health, "Occupational Exposure to Noise," p. IV-10.) Likewise, studies have tended to show greater tension-related diseases among workers in noisy factories but have not been able to isolate the effects of noise from its correlates of heat, dirt and so on. (See NIOSH, "Occupational Exposure to Noise," p. IV-11; and Jeanne M. Stellman, M.D., and Susan M. Daum, M.D., *Work Is Dangerous to Your Health* [New York: Vintage Books, 1973], p. 104.) Other studies more carefully controlling for noise have shown no effects on mental upset. (See William Burns, *Noise and Man* [London: John Murray, 1968], pp. 113-114.)

[14] One researcher has found that wages for white males are 7-13 percent higher, other things being equal, for workers exposed to any one of the following unpleasant working conditions: noise, wetness, heat, fumes, or hazards. However, the study did not distinguish the separate effects of noise on wages. See Robert E. B. Lucas, "Working Conditions, Wage Rates, and Human Capital: A Hedonic Study," pp. 208-210.

noise-related behavior what people are willing to pay to rid themselves of the irritability of noise.

Perhaps the best way to find out something about willingness to pay for noise abatement is to look at residential property values at noisy sites, such as those around airports. Because noise is an irritant, people should demand compensation for being exposed to it—or conversely, be willing to pay to get away from it. We should therefore observe that homes near noisy airports should sell for less than homes of comparable age and construction in quieter neighborhoods. People who decide to locate near the airport are being compensated for the noise they must endure, while those who choose to live in a quiet neighborhood demonstrate by their actions that they are willing to pay more for their home precisely because it is quiet. The property value differential due to noise (that is, after controlling for other factors which make housing prices vary) is therefore a good indication of what people are willing to pay, at least at the margin, to rid themselves of exposure to noise.

There is very strong evidence that single-family homes near major metropolitan airports sell for about 10 percent less than comparable homes in quiet neighborhoods. Four different studies which carefully controlled for other factors influencing housing values all came to the conclusion (using different data sets) that roughly a 10 percent property value reduction related to noise exists in neighborhoods close to major airports.[15] Because the difference in noise levels (averaged over time) between airport and quiet suburban locations is 20 to 25 decibels (80 to 85 decibels as against 55 to 60 decibels) the results of these studies can be translated into a .4 percent or .5 percent reduction in property values for each decibel increase in noise. The results of the studies are summarized in Table 1 where it is seen that families owning a typical house are willing to pay from $120 to $150 per

[15] See Jon P. Nelson, "The Effects of Mobile-Source Air and Noise Pollution on Residential Property Values," Report No. DOT-OS-40094 submitted to the Department of Transportation, Washington, D. C., January 1975, Chapter 8, for a review of these studies. A fifth study, also reviewed by Nelson, found a 32 percent reduction in property values around airports. Nelson, however, believes that the findings of this study result from faulty statistical procedures. Indeed, one of the three cities in this latter study is Los Angeles, and other evidence (see the text) from Los Angeles contradicts the 32 percent estimate and supports the 10 percent finding. Unfortunately, there are no independent estimates of property value reductions in the other two cities, Dallas and New York.

Table 1

SUMMARY OF EFFECTS ON PROPERTY VALUES OF NOISE EXPOSURE

Study (year)	City	Source of Noise	Per Decibel Percentage Reduction in Property Values	Estimated Dollar Value of Reduction per Decibel on a Home of $30,000
Nelson (1975)	Washington, D. C.	Airport	.5%	$150
Price (1974)	Boston	Airport	.4%	120
Dygert (1973)	San Francisco	Airport	.5%	150
Emerson (1969)	Minneapolis	Airport	.4%	120
Nelson (1975)	Washington, D.C.	Traffic	.2%	60

Source: Jon P. Nelson, "The Effects of Mobile-Source Air and Noise Pollution," Report No. DOT-OS-40094, submitted to the U.S. Department of Transportation, January 1975, Chapters 7 and 8.

decibel to rid themselves of noise.[16] These estimates are consistent with the findings of a court in Los Angeles that 520 homeowners under the landing approach to Los Angeles International Airport had suffered an average loss (in 1964 prices) of $1,700 as a result of increased jet flights over their homes.[17] Multiplied by a factor of 1.5 to account for housing price inflation, and assuming a 20-decibel increase in noise levels around airports, the $1,700 loss implies a current estimate of a $130 per decibel reduction in property values.

There are several reasons to believe, however, that these estimates of per decibel reductions in property values probably overstate the willingness of workers to pay for reductions in factory noise. First, there is some evidence that people are more bothered by noise at home than at work.[18] Airport noise, for example, is intermittent, while factory noise tends to be constant.

[16] The mean value of single-family housing in the most recent study—which was of the Washington, D. C., area—was between $28,000 and $31,000 (1970). See ibid., p. 8.13.

[17] "Airport Commission OKs Easement Payments to 552," *Los Angeles Times*, February 11, 1975, p. 21. It is also interesting to note that the Los Angeles County Assessor's Office uses, as a rule of thumb, the 10 percent decrease in property values around airports.

[18] Wyle Laboratories, *Community Noise*, report submitted under Contract 68-04-0046 to the U.S. Environmental Protection Agency, Washington, D. C., December 31, 1971, p. 65.

It is widely agreed that intermittent sounds with the same average intensity as a constant sound are perceived as more irritating by the listener.[19] Also, homes are probably regarded as one's primary haven from outside intrusions, including the noise of others.

The second reason why property values may overstate the willingness of a worker to pay for factory noise reduction is that homes are used by more than one person and for a greater number of hours per year than are spent in a factory.[20] Third, the decline in property values associated with airport noise probably also captures the effects of nuisance unrelated to noise. For example, 21 percent of those extremely bothered by aircraft overflights were primarily bothered by interference with TV reception.[21] There is also evidence that part of the nuisance created by aircraft overflights is the fear of crashes.[22]

The effects on property values of noise generated by sources other than aircraft can help control for the third problem above. One study (see Table 1) found that traffic (especially truck) noise causes a $60 per decibel reduction in property values. The only other major study of the effects of traffic noise on property values found an $82 per decibel decrease.[23] These findings are consistent with the assertion that it is more than aircraft noise which causes property values to decline near airports.

These studies indicate that people are willing to pay something between $60 and $150 to obtain a one-decibel reduction in

[19] Theodore J. Schultz, "Noise Assessment Guidelines, Technical Background," Report No. TE/NA 172 to U.S. Department of Housing and Urban Development, Office of Research and Technology, 1972, p. 19.

[20] It is not clear how to standardize for the number of people affected and the hours of exposure. For example, if the husband is willing to pay $2500 to avoid noise but his wife is only willing to pay $2000, it may well be that they would only buy near an airport if the property value differential were at least $2500. If such a decision were influenced by the most noise-sensitive spouse, property value decreases would represent the "willingness to pay" of the most sensitive family member and would not be the sum of the "willingness to pay" of each family member. We therefore make no adjustments of this sort, although it is recognized that the failure to do so probably overstates the "willingness to pay" to avoid industrial noise.

[21] Wyle, *Community Noise*, p. 64.

[22] Studies have shown that fear of airplane crashes has an effect on airport-related annoyance levels at least twice that of noise. See Paul N. Borsky, "Community Annoyance with Aircraft Noise Reported by Residents in the Vicinity of JFK Airport—1972," Report No. DOT-TST-75-64 submitted to the U.S. Department of Transportation, Washington, D. C., December 1974, p. 9 and Table 13.

[23] Nelson, "The Effects of Mobile-Source Air and Noise Pollution," Chapter 7.

noise exposure, although, according to our argument above, the lower-bound figure is probably more representative of what the typical person would be willing to pay for a reduction in factory noise. It should be stressed that these figures have been capitalized into residential property values and therefore represent what people are willing to pay, on a one-time basis, to obtain reduced irritation over several years. Because both the costs and the benefits are stated on a one-time basis, cost and benefit figures are directly comparable. All that needs to be done is to estimate the average reduction of noise levels which would be attained under the 90-decibel and 85-decibel standards.

Table 2 contains estimated noise exposure distributions for production workers, in manufacturing and utilities, contained in the report to OSHA by Bolt, Beranek and Newman. From these, one can estimate the average noise level in three situations: continued weak enforcement of the current 90-decibel standard, full enforcement of OSHA's 90-decibel standard, and enforcement of NIOSH's recommended 85-decibel standard. The second and third options would lower estimated average noise levels,

Table 2

DISTRIBUTION OF NOISE EXPOSURE FOR PRODUCTION WORKERS, MANUFACTURING AND UTILITIES INDUSTRIES

Decibel Level	Estimated Percentage of Workers Exposed to:		
	90-dBA standard		Enforced 85-dBA standard
	Unenforced	Enforced	
80	30	30	92
85	40	62	4
90	15	4	2
95	7	2	1
100	4	1	1
105	2	1	0
110	1	0	0
115		0	0
Average dBA level	87 dBA	84 dBA	81 dBA

Source: Bolt, Beranek and Newman, "Impact of Noise Control at the Workplace," Report No. 2671 submitted to the U.S. Department of Labor, Occupational Safety and Health Administration, Office of Standards, January 1974, pp. 13, 26.

compared to what they are currently, by three and six dBA, respectively.

Because there are reasons to suppose people would be willing to pay more to reduce residential noise than they would be willing to pay to reduce factory noise, and because airplane overflights create nuisances other than noise, I believe that the most reliable estimate of the amount they would be willing to pay for a reduction of factory noise is $60 per decibel. However, the upper bound figure of $150 per decibel will also be used for comparative purposes. For the same number of production workers used by Bolt, Beranek and Newman in their study (14,382,000), I estimate that workers would be willing to pay $2.6 billion (and perhaps as much as $6.5 billion) for the reduction of noise-related irritation associated with the 90-decibel standard. Likewise, they would be willing to pay $5.2 billion (and perhaps up to $13 billion) for the tension-related benefits of the 85-decibel standard. Both sets of estimated benefits are considerably below the estimated respective costs of $13.5 and $31.6 billion.

Using the implicit assumption that residential property values reflect only the irritability of noise, and not the hearing loss effects,[24] the best estimate is that workers must be willing to pay at least $10.9 billion for hearing loss benefits in order to justify enforcing OSHA's 90-decibel standard. The comparable figure for the 85-decibel standard is $26.4 billion. The hearing loss benefits required to justify each standard could, however, be as low as $7 billion and $18.6 billion, respectively, if our alternative estimates of the tension-related benefits are employed.

Before moving on to an analysis of the hearing loss benefits, let us briefly consider whether there are other benefits which have been ignored. NIOSH listed the possible ill effects of noise in four categories: hearing loss, physical and psychological disorders, interference with speech communications, and disruption of job performance. Hearing loss and annoyance aside, the evidence on the other adverse effects of noise is weak. Noise has been shown to affect job performance adversely only in tasks requiring extreme mental demands,[25] while there is no systematic

[24] This assumption appears to be reasonable, given the general lack of knowledge people can be presumed to have on noise-induced hearing loss.

[25] NIOSH, "Occupational Exposure to Noise," p. IV-14. Jobs requiring extreme mental demands are probably those least likely to be noisy. Employers bear the cost of disrupted or lowered productivity and will therefore take steps to reduce noise levels for jobs requiring relative quiet in order to be performed effectively.

evidence that noise causes physical or psychological disorders. Indeed, one expert contends that "on the evidence which exists it is difficult to see how major effects on health, if they existed, could so far have escaped detection." [26]

Interference with reception of speech for social purposes has most likely been accounted for in the irritation-related benefits, but such interference may also cause accidents by masking warning shouts or signals. NIOSH regarded the argument that noise is a causal factor in accidents as "plausible," but conceded there was no evidence for this.[27] The only published study purporting to show a causal link between noise and accidents was put out in 1950, but the study did not control for the other factors—probably also existing in noisy departments—which affect work injuries.[28] Using Bolt, Beranek and Newman data on noise for seventeen manufacturing industries, and controlling for other variables such as new-hire rates, percent female and black, wage rates and the size of death-related wage premiums, I could find no evidence that noise itself contributes to injuries. While a study of seventeen industries cannot be regarded as even close to conclusive, the absence of other evidence on the subject is highly suggestive. Noise abatement firms, in particular, have strong incentives to try to establish the above linkage and have had at least twenty-five years to do so. The fact that the linkage has not been proven may fairly be taken as evidence that if noise is a contributing factor to occupational injuries, it is a minor one.

Benefits: Reduced Risk of Hearing Loss. It is well established that prolonged exposure to noise over 75 or 80 decibels may eventually result in hearing loss. The hearing loss first occurs at frequencies above the normal range of speech and only gradually moves down to the frequencies of 500 to 2000 vibrations per second where normal speech takes place.[29] The usual practice is to regard hearing as impaired only if a person has a 25-decibel or greater loss in hearing threshold level averaged for both ears over frequencies of 500, 1000 and 2000 vibrations per second. The greater losses at higher frequencies make it very difficult for hearing aids to compensate for noise-induced hearing loss. Amplification so

[26] Burns, *Noise and Man*, p. 114.

[27] NIOSH, "Occupational Exposure to Noise," p. IV-13.

[28] Willard A. Kerr, "Accident Proneness of Factory Departments," *Journal of Applied Psychology*, 1950, pp. 167-170.

[29] Burns, *Noise and Man*, p. 185.

that higher-frequency sounds can be heard renders sounds in lower frequencies unbearably loud.

Estimating the extent of hearing impairment among workers under the three noise abatement alternatives considered in this chapter must take account of the fact that for most people such hearing loss occurs over a long period of time. In particular, the incidence of hearing impairment increasingly rises with years of exposure, most noticeably after twenty years.[30] Therefore, the incidence of loss at retirement is the best basis for comparing such loss across the three alternatives. This basis also has the advantage of controlling for the effects of aging on the loss of hearing.

Two available studies document the relationship between occupational noise exposure and hearing loss. One is cited in the Bolt, Beranek and Newman study,[31] and its results are shown as the "low" estimates of hearing loss in Table 3 below. The results of the other study, cited in the NIOSH document,[32] are shown as the "high" estimates of the table. Both sets of figures relate to hearing loss, at retirement, for workers exposed to the indicated noise levels for twenty to forty years. Because a noise level of 80 dBA or lower is thought to be "safe," the hearing loss at 80 dBA can be considered as the normal amount associated with the aging process. The data on hearing impairment indicate that while 20 to 25 percent of non-noise-exposed retirees would exhibit hearing impairment, around 70 percent of workers retiring from jobs which exposed them to 100 dBA daily would suffer significant loss. Weighting the incidence of hearing loss at each noise level by the fraction of workers exposed to that level (Table 2) yields the estimated average incidence under the three noise abatement alternatives we are considering. From the lower panel in Table 3 it can be seen that fully enforcing the 90-decibel standard would save 5 percent of manufacturing workers from exhibiting hearing loss at retirement, while the 85-decibel standard would reduce the incidence of hearing loss by eleven to sixteen percentage points.

In the previous section, it was estimated that the 14,382,000 manufacturing/utilities workers would have to be willing to pay around $10.9 billion for hearing loss benefits alone to justify the

[30] See, for example, the data presented in Stellman and Daum, *Work Is Dangerous to Your Health*, p. 117. Also see NIOSH, "Occupational Exposure to Noise," Table XII.

[31] Bolt, Beranek and Newman, "Impact of Noise Control at the Workplace," p. D-2.

[32] NIOSH, "Occupational Exposure to Noise," Table XII.

Table 3

INCIDENCE OF HEARING LOSS AT RETIREMENT FOR WORKERS EXPOSED TO VARIOUS NOISE LEVELS FOR THEIR ENTIRE CAREERS

Decibel Level	Percentage of Retirees with Hearing Loss[a]	
	Low impact of regulations	High impact of regulations
80	24%	20%
85	32	35
90	42	49
95	52	63
100	64	76
105	76	88[b]
110	88	94[b]
115	94	100[b]
Weakly enforced 90-dBA standard	36	38
Fully enforced 90-dBA standard	31	33
Fully enforced 85-dBA standard	25	22

[a] "Low" and "high" are in reference to the estimated impact of the regulations on hearing impairment. One reason for obtaining the lower impact is that a larger proportion of retirees are estimated to have impairment even when not exposed to dangerous levels of noise. The estimated percentage of retirees with hearing impairment unrelated to noise is shown in the 80-dBA row. It will be noted that the "high" series starts lower, but rises more rapidly, than the "low" series.

[b] The NIOSH study (NIOSH, "Occupational Exposure to Noise," Table XII) from which these figures were taken did not have hearing loss data beyond exposures to 100 decibels. These figures are arbitrary estimates which seemed reasonable in relationship to the "low" estimates derived from the Bolt, Beranek, and Newman study (Bolt, Beranek and Newman, "Impact of Noise Control at the Workplace," p. D-2).

90-decibel standard. This figure implies that each must be willing to pay at least $758—on a one-time basis—to obtain a probability of hearing loss five percentage points lower than otherwise. To justify the 85-decibel standard probably requires that workers be willing to pay $1835 apiece for the 11 to 16 percentage point reduction in hearing impairment risk afforded by that standard. Would workers be willing to pay these amounts?

Posing the question in terms of whether all workers at risk would be willing to pay a relatively small sum for a small reduction in that risk emphasizes the aspect of uncertainty inherent in the decision; no one individual can be sure in advance whether he will or will not have impaired hearing at retirement. However, the question of willingness to pay can probably be most easily considered if we pretend that people's ultimate fates are known with certainty and ask the equivalent question: would the 719,100 workers whose hearing at retirement would be saved from impairment by the 90-decibel standard—5 percent of 14,382,000—be willing to pay about $15,000 for the benefit of unimpaired hearing? To justify the 85-decibel standard, workers would have to be willing to pay between $11,500 and $16,500 to keep from having certain hearing loss upon retirement. (If the most optimistic estimates of tension-related benefits are used, the hearing loss benefits required to justify enforcement of either the 90-decibel or 85-decibel standards must be around $10,000 to each person who otherwise would have become impaired.)

The answer to the question whether one might expect workers to be willing to pay these amounts is, of course, highly dependent on how serious the hearing loss is for the typical impaired worker. Data cited by the Environmental Protection Agency, while appearing to yield lower estimates of the incidence of impairment than those in Table 3, nevertheless indicate that workers close to those typically impaired—the tenth percentile of the population when ranked by sensitivity to noise—do not suffer threshold losses (in the speech range) too much above 25 decibels from forty years of exposure to 90-decibel noise.[33] Because losses of 25 to 39 dBA are considered "slight," where the person only has difficulty with faint speech,[34] it is a fair guess that the typical worker who suffers noise-induced hearing loss has only a "slight" impairment.

This guess receives indirect support from some facts pertaining to workers' compensation payments for hearing loss. It has been estimated that only around 10 percent of those workers eligible for workers' compensation disability benefits for hearing loss actually apply.[35] While much of this failure is attributed to ignorance of the benefits, it does not seem too far-fetched to

[33] Bureau of National Affairs, *OSH Reporter: Current Report*, December 20, 1974, p. 887.

[34] Burns, *Noise and Man*, p. 205.

[35] "Noise-Sound without Value," *Safety Standards*, January-February 1969, p. 307.

speculate that this apparent ignorance stems from the fact that most eligible workers may have such slight disabilities that they do not bother to see a doctor (who might pass along information about eligibility) or desire to go to the trouble of documenting their case. New York, which has compensated workers for partial hearing loss since 1938, has roughly 100 workers' compensation cases per year involving hearing impairment. Of those workers who do obtain compensation, the average awards suggest hearing losses of around 40 decibels,[36] where frequent difficulties with normal speech begin to occur. Given that these 100 cases probably involve degrees of hearing loss greater than the average loss suffered by all those potentially eligible, for the reasons suggested above, it seems reasonable to conjecture that the typical case of hearing impairment is "slight."

My own guess is that workers would not be willing to pay $14,000 to $15,000 (or even $10,000) to avoid a "slight" hearing loss with certainty, particularly when the loss is ten to forty years away. The sums involved represent at least an entire year's income for the typical worker, and the losses sustained by the typically impaired worker are apparently not severe enough to motivate actions which would ultimately lead to workers' compensation awards. While incapable of support from market-related behavior, this speculative assertion does receive some support from looking at workers' compensation awards for hearing loss. These awards typically fall into the $2,000 to $3,000 range[37] for cases we have argued are probably more severe than average. Thus, the political process appears to put the typical value of hearing impairment at less than $3,000.

Concluding Comments. Based on this analysis, I conjecture that workers would not be willing to pay the costs of either the 90- or 85-decibel noise abatement programs. Because the beneficiaries would probably rather spend the $13.5 or $31.6 billion on other goods or services, OSHA should not enforce either standard. If for political reasons one of these two options must be adopted, there will be a smaller loss to society if the 90-decibel standard is enforced. For example, if workers are only willing to pay $5,000

[36] This estimate is based on a comparison of actual payments to maximum payments in order to compute the percentage of disability. The percentage of disability can then be related to decibels of loss.

[37] See "Noise-Sound without Value," pp. 3-7 and State of New York, Workmen's Compensation Board, *Compensated Cases Closed, 1971*, Research and Statistics Bulletin No. 27 (July 1974), p. 70.

to avoid hearing impairment of the kind typically found, costs of the 90-decibel standard would exceed benefits by $7.2 billion, while those of the 85-decibel standard would exceed benefits by $14.9 to $18.2 billion.

It is obvious that these policy conclusions rest on some speculative assumptions about workers' willingness to pay. In particular, two assertions were made that are incapable at the moment of being convincingly demonstrated: (a) that the "typical" case of noise-induced hearing loss involves only "slight" impairment, and (b) that workers would not be willing to give up—on a one-time basis—a full year's income to avoid the certainty of such impairment. Such is the weakness of the data with which policy makers must work. However, by estimating how much workers would have to be willing to pay in order to justify the program, the policy maker is forced to think systematically about the problem—thus reducing the degree of speculation or arbitrariness inherent in a less-considered decision. In other words, by benefit-cost analysis the problem is at least reduced to a size and a focus which is susceptible to rational discussion. In cases such as those illustrated in this chapter, benefit-cost analyses are not (owing to data limitations) so much the sources of definitive answers as they are useful techniques for helping decision makers structure their analysis of the problem.

It should be stressed that the estimate of benefits must attempt to discover (or guess) what the beneficiaries themselves are actually willing to pay for the benefits—not what someone thinks they should be willing to pay. If individuals with accurate information about risks show little concern about them, and if we are willing to let people decide important personal issues for themselves, then government bureaucracies (like OSHA) are not justified in pronouncing workers "irrational" and (by inflating benefits) forcing more safety upon them than they would voluntarily choose.

Summary

This chapter has indicated the usefulness, as well as the limitations, of benefit-cost analysis related to standard-setting by OSHA. In particular, three aspects of the proposed noise standard were reviewed, using the theoretical guidelines suggested in Chapter II. It was argued that the prohibitions against industry-specific standards and use of ear plugs to achieve mandated noise levels

are ill-considered. However, the reluctance of workers to wear ear plugs voluntarily clearly indicates that the costs of discomfort outweigh the benefits of reduced risk of hearing loss; therefore, noise abatement through enforced use of personal protection devices would reduce the happiness of workers. Put differently, workers would not be willing to pay the costs (including the psychic costs of discomfort) of a noise abatement program relying on personal protective devices.

It was also argued, on the basis of a benefit-cost analysis, that workers would probably not be willing to pay the costs of noise abatement accomplished through engineering controls. Noise-related decreases in housing prices were used to estimate the value, to workers, of the tension-related benefits of quieter factories. However, because there does not exist market-related evidence on workers' willingness to pay for reduced risk of hearing loss, the excess of costs over tension-related benefits was used to estimate what this willingness would have to be in order to justify either the 90- or 85-decibel standard. The available evidence suggests that neither workers nor legislatures value the hearing loss which typically occurs at anywhere near the value required to justify enforcement of either standard. This assertion is admittedly speculative, but at least the formal analysis of OSHA's options should enable the decision maker to narrow the problem and will force him to reveal his key assumptions.

CHAPTER IV

OSHA'S IMPACT ON WORK INJURIES

> *. . . [The act], if enacted will result, I feel certain, in a substantial reduction in work-related death, illness and injury.*
>
> U.S. Representative Carl Perkins, 1970

The statement above, made by Representative Perkins (D.-Ky.) during the House debate on the Occupational Safety and Health Act, expressed the widespread hope and expectation that the act would reverse the upward trend of work injuries and significantly reduce the risks facing American workers. While the preceding chapters have analyzed the desirability of the act's goals, this chapter takes up the question whether OSHA has in fact achieved its goal (or is likely to achieve it) of reducing the incidence of job-related injuries and illnesses—leaving aside the question of the goal's desirability. Owing to the lack of data on illness, all of the specific analysis in this chapter will pertain to work injuries, though, of course, many of the more general comments will also pertain to illnesses.

The first section analyzes OSHA's enforcement program, particularly considering its likely impact on work injuries. The second section reports on attempts to make actual estimations of OSHA's success in reducing injuries, given our limited data.

OSHA's Enforcement Program

One element in the evaluation of OSHA's effectiveness in reducing on-the-job risks is an analysis of its standards enforcement pro-

gram. The immediate purpose of this program is, of course, to secure compliance with OSHA's standards. However, the ultimate goal of compliance is a reduction in the incidence of work injuries and illnesses. Thus, the effectiveness of the program is really a function of (a) the extent of compliance the program induces, and (b) the degree to which standards actually relate to work injuries and illnesses. These factors will be discussed separately.

Compliance with OSHA's Standards. To induce compliance with its standards, OSHA employs compliance officers who make unannounced inspections of plants subject to the act. Highest inspection priorities are assigned to plants where (a) there is evidence of imminent danger to employees, (b) there has been a fatality or catastrophe, (c) valid employee complaints about violations have been received, and (d) serious citations have recently been cited or the employer has failed to notify OSHA of the abatement of nonserious citations. Roughly 28 percent of OSHA inspections fall into the above categories, with 15 percent of all inspections in the follow-up category alone.[1] The remaining 72 percent of inspections are associated with the Target Industry Program (to be described later), the Target Health Hazard Program, or OSHA's program of general random inspections.

The extent to which these inspections encourage compliance among both inspected and uninspected plants is the central issue of this section. Unfortunately, one cannot tell from overall compliance rates whether or not OSHA has induced compliance; after all, some plants have always maintained "good" safety practices. Likewise, one cannot be sure whether a high compliance rate implies the existence of "good" practices or of less-than-comprehensive inspections. For examples of these problems in interpreting compliance rates, let us consider the fact that initial general schedule inspections—the lowest priority—have an average compliance rate of 21 percent, while the compliance rate is well over 40 percent for accident-related, complaint-related, and Target Industry Program inspections.[2] If compliance rates truly

[1] Walter Oi, "On Evaluating the Effectiveness of the OSHA Inspection Program," Paper presented at the Department of Labor Conference on Evaluating OSHA (Annapolis, Maryland; March 18, 1975), p. 50. See also, U.S. Congress, Senate, Subcommittee on Labor of the Committee on Labor and Public Welfare, *Occupational Safety and Health Act Review, 1974*, July 22, 30, 31 and August 13-14, 1974, p. 1012.

[2] The accident- and complaint-related compliance rates are inferred from Oi, "On Evaluating the Effectiveness of the OSHA Inspection Program," p. 53. The compliance rate for follow-up and complaint inspections are not given

reflect hazards and OSHA does not encourage much compliance in advance of inspection, these rates would imply that OSHA's inspection priority system is exactly the reverse of what it should be. However, it could be that the Target Industry Program encourages pre-inspection compliance, while the higher rates in the other top-priority categories are the result of more narrowly focused inspections wherein the inspector looks only for accident- or complaint-related violations. If the latter were true, OSHA's inspection priorities would not necessarily be backward.

The ambiguities in the interpretation of observed compliance rates suggest that OSHA's efforts at encouraging adherence to its standards must be judged according to the incentives for compliance. Consideration of these incentives must begin with the realization that OSHA's overall purpose is to force firms to supply more safety and health to workers than they would otherwise supply. Put in the context of our discussion in Chapter II, OSHA is requiring firms to produce more safety and health than they have in the past found profitable, and it therefore needs to impose penalties for noncompliance.

The employer who is not already in compliance with OSHA's standards is faced with a decision whether to comply, bearing the costs of compliance immediately, or to remain out of compliance until caught. Once caught, he will have to bear the costs of compliance as well as pay a penalty for noncompliance. Obviously his decision (assumed to be made yearly, for the sake of discussion) will depend on (a) the probability of inspection each year, (b) the probability, once he is inspected, of having his violation detected, and (c) the penalties assessed if the violation is discovered. If there is a one-in-ten chance of being caught in a violation during a year, the penalty for noncompliance would have to be about nine times greater than the yearly cost of compliance in order to induce a calculating businessman to comply (this is because the odds are nine to one that he will not get caught and will therefore not have to bear OSHA-related costs at all). Obvi-

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separately, but the combined rate is not below 59 percent in any manufacturing industry. Given an average 75 percent compliance rate for follow-up inspections and the fact that such inspections outnumber complaint inspections by roughly three to two, it is not unreasonable to conjecture that the compliance rate for complaint inspections must be at least 40 percent in all industries. The Target Industry Program and follow-up compliance rates are published in U.S. Senate, *Occupational Safety and Health Act Review*, 1974, p. 1012.

ously, the greater the chances of getting caught and the smaller the costs of compliance, the lower the penalty needs to be.

The typical costs of compliance with OSHA are difficult to estimate objectively, but they are probably large. A National Association of Manufacturers (NAM) survey came up with estimates of $35,000 for firms of 1–100 employees, $73,500 for firms of 101–500 employees, and $350,000 for firms of 501–1,000 employees.[3] The estimates this study obtained could, of course, be biased upward in an attempt to persuade the government to adopt a go-slow approach to job safety and health. However, the estimates do receive some support from the fact that the first thirty-three businesses that obtained loans from the Small Business Administration for the purpose of compliance with OSHA needed an average loan of $200,000.[4] While these businesses are likely to be those at the extremes of the compliance cost distribution, it is at least significant that the $200,000 figure is certainly not below—and is, in fact, well above—the NAM estimates for the typical small business.

Even if the costs of compliance are so biased as to be 100 times too large, the incentives for compliance in advance of an inspection are almost negligible. First, the probability of being inspected is small. Only 1.3 percent of all covered plants were inspected in fiscal year 1973, implying the typical establishment will see an OSHA inspector once every seventy-seven years, about as often as we see Halley's Comet. However, because OSHA has concentrated on inspecting large firms, the average worker will see an OSHA inspector once every ten years.[5] Even the largest manufacturing plants (over 1,000 employees) have only this 10 percent chance of inspection each year.[6]

Second, there is substantial evidence that inspectors do not discover or cite all violations in the plants they inspect. Indeed, with some 2,100 detailed standards applying to industry generally, and 2,300 more pertaining to special industries such as construction and longshoring, it is not unreasonable to conjecture that most inspectors are not even aware of all the possible violations. One

[3] "What It's Costing Industry to Comply with OSHA," *Occupational Hazards*, Fall 1974, pp. 8-9.

[4] Research Institute of America, Inc., *The Occupational Safety and Health Act, Where It's at and Where It's Headed*, File 33 (New York, April 2, 1973), p. 36.

[5] U.S. Senate, *Occupational Safety and Health Act Review, 1974*, p. 989.

[6] Oi, "On Evaluating the Effectiveness of the OSHA Inspection Program," p. 54.

indication that inspectors only find the more obvious violations is the fact that in May 1974 only 636 of the 4,400 standards were even cited once,[7] while in fiscal year 1973, twenty-two standards—one-half of 1 percent of the total—accounted for 42 percent of all violations.[8] Further evidence that inspectors catch only the obvious is that, for the technologically diverse industries of food products, lumber and wood products, and transportation equipment (all of which are included to some extent in the Target Industry Program), the same standards tend to be the ones most cited from industry to industry. Three of the five most-frequently violated standards in each industry are the same: electrical code violations, abrasive wheel machinery, and general requirements for all machines. The standards on mechanical power transmission and wood-working machinery are among the top five in at least two of the three industries.[9] It therefore seems safe to say that inspectors only cite those standards with which they are familiar and that many violations are undoubtedly never caught.

Third, the penalties for violations are almost trivial. The average noncomplying establishment is fined around $170—or $25 per violation. The low fines are the direct result of the fact that 98.7 percent of all violations are deemed to be "nonserious," drawing fines averaging $16.[10] Serious violations, resulting in fines averaging $648, account for just 1.2 percent of the total—apparently because inspectors want to avoid the time and effort necessary to document a serious citation that is likely to be litigated.[11] Indeed, the disparities among regional offices of OSHA in the percent of all violations regarded as serious—ranging from .3 percent to 3.5 percent—is strongly suggestive evidence that the seriousness of the citation is a matter of policy, not of working conditions.[12]

The small probabilities of inspection, the likelihood that many violations may never be detected even if an inspection is made, and the low fines combine to provide extraordinarily weak incen-

[7] U.S. Department of Labor, Occupational Safety and Health Administration, "What Are the Most Frequent Violations?" internal document for May 1974.

[8] U.S. Department of Labor, Occupational Safety and Health Administration, "Standards by Frequencies of Violations," internal report dated September 11, 1973.

[9] Oi, "On Evaluating the Effectiveness of the OSHA Inspection Program," p. 56.

[10] U.S. Senate, *Occupational Safety and Health Act Review, 1974*, p. 967.

[11] Ibid., p. 996.

[12] Ibid., p. 993.

tives for compliance with OSHA standards in advance of inspection. Incentives to comply after inspection are much stronger, given that fines for willful and repeated violations average $1,104.[13] However, only 23 percent of the plants with violations are subject to a follow-up inspection, so that even failure to abate is not certain to be detected.

OSHA's policy of imposing very small penalties for noncompliance is apparently based on the premise that compliance will increase the profits of businessmen. Indeed, a former assistant secretary of labor for occupational safety and health maintained

> that OSHA prefers to achieve voluntary compliance through its training, education, and information programs. The programs are based on an enlightened relationship existing between OSHA and the vast majority of the business community. In other words, I am assuming that most employers will comply with OSHA's standards if they know what they need to do and are convinced that a safe and healthful workplace pays.[14]

To expect that businessmen can be induced to invest thousands of dollars to comply in advance of inspection by a less-than-10 percent chance of being fined $170 assumes that they would profit from compliance even if there were no chance of inspection. This assumption, in turn, presumes that businessmen are woefully ignorant of how profitable safety really is and presumes that OSHA standards can be shown to have a marked effect on the injury rate. The first presumption is contradicted by the evidence, cited in Chapter II, that businessmen do supply safety when there are market incentives to do so. The second presumption is discussed in the remainder of this chapter.

Relationship of Standards to Injuries and Illnesses. In order for OSHA to have its desired impact on injury and illness rates in plants which have been induced to comply, it must be true (a) that a significant number of injuries are the result of the kinds of hazards that can be effectively dealt with by standards, and (b) that the OSHA standards in force actually reduce these hazards.

Two studies have been done which shed some light on how many injuries (not illnesses) could be prevented by a set of comprehensive standards. A Wisconsin study of accidents classi-

[13] Ibid., p. 967.

[14] Memorandum from Mr. John H. Stender, assistant secretary of labor for occupational safety and health, to Mr. James L. Blum, dated October 31, 1973.

fied by type concluded that most injuries result from some behavioral problem or transitory hazard, and that only one-quarter of all injuries involve a permanent physical hazard capable of control by a standard-setting and inspection program.[15] A more careful study done in New York, based on an analysis of individual case histories of injuries, estimated that only 36 percent of injuries resulted from hazardous conditions, although no distinction was made between transitory and permanent hazards.[16] Because standards emphasize physical hazards, and these hazards must be nontransitory in order for the standards to be effectively enforced by inspections, it would seem to be that even the best standards could only reduce work injuries by at most one-third or one-fourth.

Whether the standards actually promulgated and enforced do in fact reduce injury-related hazards is, of course, of paramount interest. There are at least three ways for evidence to be obtained on this question. One method is to correlate compliance and injury rates; if OSHA's standards really do relate to the hazards which are injuring workers, there should be a strong, negative correlation between these two rates. In fact, as can be verified from Table 4, there is a weak positive correlation between compliance and lost-workday injury rates across industries—that is, industries with higher injury rates tend to have higher rates of compliance. The correlation is, however, so weak that the hypothesis of "no correlation" cannot be rejected.

Because the available measure of compliance—the percentage of inspected plants with no citations—is extremely crude, a second method of relating standards to injury-causing hazards should be useful. This method directly relates the cause of individual injuries to violations (if any) of safety standards. While OSHA has not yet completed any such study, two of the most progressive states have pre-OSHA data of the type required. Because these two states were widely believed to have stringent safety codes before OSHA came into existence, and because almost all of OSHA's standards were pre-existing or consensus standards anyway, it is likely that data from these states will reasonably describe the present relationship between injuries and violations of federal standards.

[15] State of Wisconsin, Department of Industry, Labor and Human Relations, "Inspection Effectiveness Report," September 28, 1971, p. 20.

[16] State of New York, Department of Labor, Division of Research and Statistics, "Work Injuries Resulting from Industrial Code Rule Violations, New York State, 1966," Departmental Memorandum 243, p. 3.

Table 4

COMPLIANCE AND INJURY RATES, INDUSTRIES WITH OVER FIFTY INSPECTIONS IN FY 1973

Industry	Compliance Rate, FY 1973	Lost-Workday Injury Rate, 1972
Construction		
General building	33.0%	5.6%
Heavy construction	33.8	5.9
Special trades	47.2	5.8
Manufacturing		
Food	38.8	6.5
Textile mills	15.7	2.7
Apparel	17.7	1.7
Lumber and wood	25.0	9.1
Furniture	16.4	5.1
Chemicals	41.4	2.6
Stone/clay/glass	36.0	5.4
Primary metals	30.8	5.5
Fabricated metals	28.0	5.7
Machinery	29.5	3.7
Electrical machinery	31.6	2.2
Transportation equipment	42.9	4.0
Transportation/public utilities		
Water transportation	73.6	7.4

Source: Compliance data: Walter Oi, "On Evaluating the Effectiveness of the OSHA Inspection Program," Paper presented at the Department of Labor Conference on Evaluating OSHA (Annapolis, Md., March 18, 1975), p. 52; injury rate data: U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Injuries and Illnesses by Industry, 1972*, Bulletin 1830 (1974).

The New York study mentioned above, while finding that 36 percent of injuries were related to physical hazards, estimated that violations of New York safety codes contributed to 22 percent of all injuries. In contrast, Wisconsin data show that only 2.4 percent of injuries involve safety code violations. The discrepancy between the two figures is probably related to the way in which the cause of injury is determined. New York's study was for research purposes only, while the data for Wisconsin are from a fault-finding process which assesses a penalty on the employer if a violation was involved in the injury. Because fault is likely to

be assigned only in the clear-cut cases, whereas a research study need not prove that the violation was of significance in the injury, these figures probably represent upper-bound and lower-bound estimates, respectively. Thus, it is probably true that perfect enforcement of the current standards would reduce injuries by something less than 20 percent.

Because perfect enforcement of a large and complex set of standards has been shown to be highly unlikely, it is of some importance to find a direct estimation of OSHA's actual impact on work injury rates. This third method of obtaining insight into OSHA's effects on injuries is discussed in the next section.

Estimated Impact of OSHA on Work Injuries

With the small incentives for pre-inspection compliance, the limited relationship of injuries to standards violations, and the difficulties of discovering all violations in an inspected plant, it would not be surprising to find that OSHA has had a negligible impact on the overall injury rate in industry. Unfortunately, whether this is true cannot be tested, for with the existence of OSHA came a new method of gathering injury data. This new method yields estimates which are different from, and cannot be made comparable to, the old estimates of injury rates. The result is that any attempt to measure the overall effects of the act cannot distinguish between those changes in rates which are the result of enforcement and those which are merely statistical in nature.

The best that can be done toward evaluating OSHA's impact on injuries is to compare injury rate changes in inspected and noninspected plants. Because incentives for compliance are much stronger in the inspected plants, differential changes in the injury rate should be observable if enforcement of OSHA's standards does in fact reduce injury-related hazards. In the absence (to date) of the required data on individual plants, the most feasible method of estimating the effects of OSHA's enforcement program is to compare injury rate behavior in targeted and nontargeted industries.

The Target Industry Program. The Target Industry Program was announced on May 26, 1971, and its stated overall purpose was to focus OSHA resources—particularly inspection activities—on a few industries where safety hazards seemed worst. The industries selected for targeting had injury rates over twice the national

(manufacturing) average and employed 1.5 million workers over a geographically dispersed area. The industries targeted were marine cargo handling (longshoring), roofing and sheet metal, meat and meat products, lumber and wood products, and miscellaneous transportation equipment (primarily the making of mobile homes).

At the outset, the Target Industry Program emphasized cooperative safety efforts by management, labor, and the National Safety Council; studies of industry-specific safety hazards by a special OSHA unit; and priority status for inspections by OSHA compliance officers. OSHA made special efforts to inspect plants with more than twenty employees, and (as can be inferred from Table 5) almost complete inspection coverage of plants with more than twenty employees had been accomplished by the end of 1972. The high rate of coverage among targeted firms, contrasted with the lower rate of coverage elsewhere, suggests that the program should have a measurable impact. Attempting to estimate the impact of the program not only can indicate OSHA's effectiveness, but also can yield some evidence on the value of the implicit notion that OSHA can have its greatest impact by

Table 5

TARGET INDUSTRY INSPECTION COVERAGE

Target Industry (SIC Code)	Number of Employers, 1972		Cumulative No. of Inspections to:	
	Total	With > 20 employees	Dec. 1971 [a]	Dec. 1972
Meat and meat products (201)	4,098	1,922	563	1,983
Lumber and wood products (24)	26,549	5,747	1,377	6,197
Miscellaneous transportation equipment (379)	1,968	1,128	297	997
Roofing and sheet metal (176)	12,598	1,528	451	1,691
Longshoring (4463)	709	365	1,070	7,720

[a] Data for 1971 are for October to December. These data were obtained directly from the Occupational Safety and Health Administration.

Sources: Office of the President, *The President's Report on Occupational Safety and Health*, House Document No. 93-65 (1973), p. 38; U.S. Department of Commerce, Bureau of the Census, *County Business Patterns, 1972: U.S. Summary*, October 1973, pp. 15-23.

focusing its enforcement resources on those industries that have the highest injury rates.

The question we seek to answer, then, is whether the Target Industry Program has reduced work injury rates in the targeted industries below what they otherwise would have been in the absence of the program. Probably the best way to predict what injury rates would otherwise have been in, say, 1972 or 1973 would be to see what the relevant rate was before 1972 and 1973. However, the correspondence between past and present injury rates, even in the absence of an OSHA inspection, is not likely to be perfect. In particular, we must take into account changes in the statistical series, in the business cycle, in long-run effects on injury rates from technological or labor market factors, and in the level and pattern of past injury rate changes particular to each industry. The procedures employed to control for these factors in effect used nontarget industry data on injury rates for the years 1968–70, as well as recent employment changes, to establish a general relationship between these variables and injury rates for the years 1972–73. Injury rates actually measured in the target industries were then compared to those estimated to have existed in the absence of the program, using the relationship between past and present rates discovered for nontarget industries. (See Appendix C for a more detailed description of the study and its results.)

Because of data limitations, the study was confined only to manufacturing industries. The most credible results are that over the 1970–72 period injury rates in the target industries fell by nearly 3 percent more than they would have fallen otherwise, but that over the 1970–73 period, they fell by less than 1 percent more than they would have in the absence of the program. The most important aspect of these results is that neither estimate is statistically distinguishable from zero. Putting it differently, we cannot reject the hypothesis that the Target Industry Program has had no effect on injury rates in its first year or two of operation. The results were qualitatively similar using data from California and Wisconsin that were not affected by pre- to post-OSHA changes in collection procedures.

At the very least, the results cast serious doubts on the effectiveness of the target program. We would have every reason to believe that the more complete inspection coverage among targeted industries would produce larger injury rate reductions in that sector if inspections were indeed effective, yet no measur-

able differential can be identified. It could be argued that the overall effect of OSHA on injury rates may be efficacious, but that targeted and nontargeted sectors have been equally affected. Even if this were the case, however, the rationale for continuing the target program would be undermined.

A more ominous, but still speculative, implication of the results of this study is that OSHA, whether because of its standards or because of its failure to discover violations, may not be affecting the conditions which cause injury. Given the limited potential of a perfectly enforced set of standards and the likelihood that inspectors discover only the most obvious violations, it is perhaps not surprising that the estimated effects on injuries are so small that they cannot be distinguished from zero.

Summary and Conclusions

This chapter has attempted to estimate OSHA's impact on work injury and illness rates. Conceptually, this impact depends on how effectively OSHA stimulates compliance and the degree to which its standards can reduce the kinds of hazards actually causing injuries. While the incentives to comply with OSHA (in advance of inspection) are weak, perfect enforcement of excellent standards could conceivably reduce injuries by as much as one-third, while perfect enforcement of the current standards could reduce injuries by somewhere between 2 percent and 22 percent in inspected firms. If we judge from the estimated effects of the Target Industry Program, the actual effects of OSHA may be virtually nil. It is difficult to say whether OSHA's negligible impact—to the extent we have measured it—is the result of faulty standards or poor enforcement. However, there is strong evidence that enforcement is less than comprehensive even in firms which have been inspected.

Given the results relating to the Target Industry Program, OSHA's concept of "worst-first" becomes at least questionable. The assumption that OSHA will have its greatest impact on the high-risk industries is simply not tenable. Technologies differ so widely across industries that large disparities in injury rates would exist even if there were complete compliance. A more useful variant of "worst-first" may be to focus on the highest-rate plants within detailed industry and size groups. This procedure would identify the plants where the largest number of injuries are occurring, given size and technology. It is likely to be these

"outlying" plants where OSHA can have its greatest impact, assuming that persistent physical hazards outlawed by OSHA are causing these plants to be more dangerous than others.

While by no means certain to prove more effective, this variant of "worst-first" is both possible and may be more promising than targeting industries with high injury rates. OSHA has, however, specifically rejected targeting inspections on this "worst-plant" basis, because such targeting would be based on the employer-submitted injury reports now collected by the Department of Labor. OSHA believes that "worst-plant" targeting would produce a situation where, to get honest reporting, OSHA would be required to take an adversary position towards business which "would further intensify a climate of distrust between OSHA and the country's employers." [17] This, OSHA concludes, would be politically unfeasible.

[17] Memorandum from Mr. John Stender to Mr. James Blum, October 31, 1973.

CHAPTER V

ALTERNATIVES TO STANDARD-SETTING AND CONCLUDING RECOMMENDATIONS

While I share the conviction that standard-setting and enforcement is an appropriate Federal responsibility, I am gravely concerned that this bill may not go far enough to reach and remove the root causes of the macabre facts of life in the working place.

U.S. Representative Phillip Burton, 1970

The only congressman who seriously questioned the standard-setting approach of the Occupational Safety and Health Act was Phillip Burton (D.-Calif.). Representative Burton argued that the primary cause of injuries and illnesses was the excess of prevention costs over potential savings to employers. He reasoned that a federal safety and health program had to change these basic economic facts and suggested that fully compensating health and workers' compensation insurance might be adopted in order to place the full costs of injuries and illnesses—and hence the savings from their prevention—on employers. This suggestion is particularly interesting because it raises the question whether alternative forms of government safety and health programs would be more desirable than the forms we have now.

The purposes of this chapter are twofold. First, the alternative forms that a government program could take will be discussed and evaluated in general terms. Second, the major highlights from each chapter will be interwoven into the discussion, and in the concluding section a series of recommendations will be made.

Summary of the Basis for a Government Safety and Health Program

In Chapter II it was argued that the goal of a government safety and health program should not be to reduce the risks workers face to the technically feasible minimum—this being the goal, which, with some qualifications, was shown in Chapter I to be the one set for OSHA by law. Instead, the government should seek to induce that level of safety and health which workers would provide for themselves if they dealt directly with the suppliers of safety inputs rather than dealing with them through their employers. To require a level of safety and health greater than that for which workers are willing to pay requires society to use resources for safety and health which the people would rather use otherwise.

The need for a governmental safety and health program arises in situations where the employer, as middleman between workers and the suppliers of safety inputs, does not provide the same level of safety and health as would be provided by fully informed workers in the event of no middleman. These situations occur when employees cannot transfer all the costs of illness or injury to the employer. It was argued (Chapter II) that governmental intervention in the area of occupational health is almost certainly justified, but that the case for a stringent governmental safety program is questionable.

The argument that governmental intervention is required to improve social welfare does not, of course, say anything about the form the intervention should take. The focus of this chapter is on alternative methods of governmental intervention. Because a variety of methods can be used to achieve the same level of safety and health, the choice of method really comes down to administrative and technical efficiency—we want to achieve the desired levels of risk with the minimum wastage of social resources. For evident reasons, we will distinguish in the subsequent discussion between achieving safety and achieving health.

Occupational Safety

Generally speaking, there are three routes which the government can feasibly take to stimulate greater occupational safety: providing workers and employers with information concerning risks and their prevention; imposing financial penalties on employers

when a work injury occurs; and requiring that employers (or employees or both) abide by a detailed set of safety standards. Because the Occupational Safety and Health Act requires the latter mode of intervention, it is convenient to begin with a consideration of standard-setting as a route to increased safety.

Standard-Setting. One can only guess why enforcement of a detailed set of safety standards was chosen by the authors of the act as the proper mode of government intervention. One reason may be that the authors did not believe the injury rate would, in fact, be responsive to the other methods of intervention—either because employers were believed to be ignorant of good safety practices or because the safety market was believed to be unlike other markets. Another reason, however, may be that standards appear to be a step toward prohibiting the hazards that cause injury, while the other methods would seem to "permit" injury and illness to occur. This distinction between the methods is in fact a delusion, because standards are anything but prohibitive—as can be seen from a careful consideration of their disadvantages.

First, standards are enormously difficult to adopt or change if they are so stringent as to be controversial. A proposed OSHA standard must go through twenty-two steps within the Labor Department, including reviews by the Standards Advisory Committee (if necessary), the office of regional programs, technical staff, the assistant secretary, the departmental solicitor and the information office—in addition to public hearings and pre-draft research. Only two of seven NIOSH recommendations for standards in 1972—and only one of thirteen since—had been adopted by mid-1975 despite the fact that OSHA assigns high priority to the development of standards from NIOSH recommendations.[1]

Compounding the delays in standard-setting is a second problem. Constant changes in technology and materials create new hazards, with which it is difficult for a detailed set of standards to keep current. A Labor Department study in 1968 reported that 60 percent of the consensus standards (which were adopted en masse in 1971) were out of date and in need of serious revision.[2] In contrast, OSHA promulgated, revised, amended or revoked only 135 standards in 1972 and appears to anticipate fewer adop-

[1] U.S. Senate, *Occupational Safety and Health Act Review, 1974*, pp. 1056-1057.

[2] Bureau of National Affairs, *Job Safety and Health Act*, p. 31.

tions in 1975.[3] One can infer, therefore, that many of OSHA's standards are not up-to-date. For example, although there are standards relating to portable wood ladders, there are none pertaining to fiberglas or other ladders made from insulating materials now frequently used by electrical contractors.[4]

Third, once promulgated, standards are difficult and expensive to enforce. Recalling the data on this point discussed in Chapter IV, we may remember that OSHA has only enough inspectors to inspect the typical worker's factory once every ten years at the most—and even then only the most obvious violations are caught. Standards are simply too detailed and too numerous to permit their complete comprehension by employer or inspector.

Fourth, it is simply not feasible to write standards which are so detailed and up-to-date that they accurately relate to hazards in all operations. One aspect of this issue has been discussed in Chapter IV: standards may only be able—potentially—to eliminate one-third or one-fourth of work injuries (assuming they are up-to-date and are set with detailed knowledge of specific hazards). Another aspect of this issue, however, is that a given standard which is promulgated and with which companies must comply may not relate to a genuine hazard in a particular firm. For example, one firm was cited for a violation because the hard hats it issued to its workers were not stamped with a statement that they met the standards of the American National Standards Institute—even though they in fact did meet such standards.[5] Employers frequently complain that they are required to comply with standards even when they have never had an injury related to the "hazard" in question:

> In the three and one-half years which I have owned this facility I have had only one lost time accident and this is one of the housekeepers who sprained her back lifting a mattress. The previous owner tells me that he had a similar safety record with virtually no lost time accidents, yet under OSHA requirements, we are asked to spend at least $50,000 to make what we honestly believe are unnecessary changes.[6]

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[3] Office of the President, *President's Report on Occupational Safety and Health*, 1973, pp. 60-67; and Bureau of National Affairs, *OSH Reporter: Current Report*, December 26, 1974, p. 868.

[4] U.S. Senate, *Occupational Safety and Health Act Review*, 1974, p. 616.

[5] "OSHA, Safety Manager's Friend or Foe?" *Occupational Hazards*, October 1973, pp. 95-96.

[6] U.S. Senate, *Occupational Safety and Health Act Review*, 1974, p. 54.

To the extent that resources are required to be spent for the correction of "hazards" which do not cause injury, the standards are unproductive and wasteful.

A fifth problem is also related to waste: standards do not necessarily require the least-cost, nor the most effective, method of injury reduction. For example, a construction standard for temporary lights requires them to have wire guards, whereas it is cheaper and just as effective to use bulbs coated with a plastic "skin" which contains the glass should it be broken.[7] It has also been shown that the radial saw guarding required by OSHA will increase the chances of injury when applied to the large saws used in sawmills.[8] While a variance was granted in the latter case, the point is that technological conditions are so diverse that centrally made rules cannot be applied to all situations without some degree of counter-productivity (including time and resources spent in justifying, and deciding upon, variances).

Finally, compliance with standards tends to be mechanistic, removing the really critical issue of worker safety and health from the focus of the day-to-day operators. Rather than worry about how best to reduce injuries and illnesses in the plant, inspectors and safety officials at the plant are induced to direct their efforts toward compliance with the standards. It is not unusual for safety directors with previously active safety programs, for example, to complain that the time their staffs used to spend on safety education, accident investigation, and analysis is now spent on fulfilling OSHA's record-keeping requirements and assuring compliance.[9]

Provision of Information. An alternative form that the federal safety program could reasonably take would be to have the government provide, and disseminate as widely as possible, information on risks, hazards, and abatement procedures. The government might for example require hazards to be labelled and accident records to be distributed to employees. The government might also do research on safety hazards, and distribute findings or warnings to employers and employees. Standards would no longer be mandatory, only advisory. In short, the job safety

[7] U.S. Code of Federal Regulations, Title 29, Section 1926.401(j)(1).

[8] Secretary of Labor v. J. H. Baxter and Company, 1 OSHC 3147, August 17, 1973.

[9] "OSHA, Safety Manager's Friend or Foe?" p. 95.

program would take on the characteristics of the government's program to reduce cigarette-caused cancer.

The advantage of providing information rather than setting standards would be that it would not require employers to respond in any particular way, leaving them free to choose the best method by which to reduce injuries. They would therefore be free to adopt flexible, up-dated, hazard-related responses to inducements for greater safety. The disadvantage is that the only inducements the program would offer toward the provision of additional safety would operate indirectly through greater employee awareness of risks and hazards. While this strategy would be entirely appropriate when there is no "middleman"—as is the case of cigarette smoking—it was previously argued (Chapter II) that employees can effectively transmit their wishes to their employers only if they can fairly easily withdraw their labor supply by quitting or striking. It is the very issue of their power to act effectively on safety information that we were unable to resolve completely in Chapter II. It is not clear that this approach, therefore, would be sufficient to reduce work injuries to their "proper" level.

While the information-provision method may not be sufficient by itself, it is important to recognize that information dissemination should be an important component of any government safety program. Educating employees on the risks they face, and suggesting to employers methods for hazard abatement, would make it possible for the labor market to function more effectively by helping transfer injury costs to employers and helping the employers choose least-cost methods of abatement.

Financial Penalties. A third method by which the government could stimulate job safety would entail a financial penalty levied on the firm for each injury. The injury "tax" could, for example, be computed from, and remitted with, the forms each plant must now file with the Department of Labor. Another alternative would be to build the penalties into the workers' compensation system, with (say) a tax proportional to the cost of each case being remitted directly or indirectly (through the insurance companies) to the federal government. The method of collection would be much less important than the issuance of a clear signal to employers that injuries would now be more costly to them. The added cost would provide incentives for employers to reduce injuries, but it would also cause the prices of goods—such as lumber—produced under hazardous conditions to rise relative to the prices of other goods.

Thus, employment in "safe" industries should tend to gain at the expense of employment in industries which are subject to large inherent risk.

An "injury tax" approach to job safety would not suffer from the disadvantages of the standards approach. It would focus attention directly on the goal of greater job safety, but leave each employer free to select the methods of reducing injuries which, in his particular case, would be least-cost. The social waste of trying to apply uniform standards to every unique situation would therefore be avoided. Also there would be avoided the problems of enforcing a set of 4400 rules on each of four million establishments. The enforcement problem would be reduced to the auditing of a few figures in each plant: the number and the distribution of job injuries. Not only could OSHA obtain verifications on injuries from workers' compensation insurance companies, much as the Internal Revenue Service now obtains verification on wages and salaries from employers, but the help of employees and labor unions could be enlisted in keeping employers honest.

Another advantage of a tax over the standards approach would be that the tax incentive would extend to all sources of injuries, not just to permanent physical hazards. The employer would thus be encouraged to employ any means to reduce injuries, not simply to remove the hazards causing at most one-third of job injuries.

The question arises here whether employers would actually respond to financial incentives. Would they perhaps continue to permit injuries and merely pass the added costs on to consumers? Even if they did this, however, the greater rise in prices for goods and services produced with risky technologies would (as previously noted) tend to shift the employment mix from relatively risky to relatively safe industries. However, the evidence cited in Chapter II (and Appendix B) is consistent with the hypothesis that employers do respond to financial incentives to improve safety. The fact that, before OSHA, there were over 35,000 safety professionals employed in the United States—fifty times the number of inspectors employed by OSHA—is evidence itself of an operating "market" for safety.[10] Employers may not be safety experts, but they can and do consult those who are when there are incentives for them to be concerned about the safety of their employees.

[10] U.S. Senate, *Occupational Safety and Health Act Review*, 1974, p. 162.

How responsive to these "taxes" can we expect the injury rate to be, given various "tax" levels? The evidence in Appendix B can help answer this question in a rough and general way. Table 6 computes the reduction in injury frequency rates (lost-workday injuries per million man-hours) estimated for all of manufacturing, given selected average levels of the injury "tax." The table suggests that moderately large fines would be required to reduce the injury rate by even small amounts—a finding interpreted in Chapter II as suggesting that job safety has been pushed to the point where it is quite costly to further reduce injuries. Fines averaging $2,000 per injury, for example, would only reduce injuries by 9 to 13 percent—indicating that between 87 percent and 91 percent of injuries would cost more than $2,000 (yearly) to eliminate.

The injury "tax" should not, of course, be set to reduce injuries by some arbitrary amount. Ideally, it should be set to equal the difference between the total cost of an added injury and that part of this added cost the employer bears. The tax should thus shift the costs of injuries to the employer, a necessary condition for employers to provide the amount of safety their employees desire. It is not possible to calculate what this tax should be in a completely satisfactory way, because the psychic costs—pain and suffering—that injuries create are not directly calculable. However, one can make some rough guesses as to what the magnitude of the tax should be in the typical manufacturing case involving only temporary disability. About 95 percent of lost work injuries,

Table 6

ESTIMATED REDUCTION IN THE MANUFACTURING INJURY RATE BY SELECTED INJURY FINES

(1970 average manufacturing injury rate = 15.2)

Fine per Injury	Estimated Reduction in Injury Rate	
	Low estimate[a] (= −.00067 × fine)	High estimate[a] (= −.00097 × fine)
$ 500	.34 (2.2%)	.48 (3.2%)
1,000	.67 (4.4%)	.95 (6.2%)
2,000	1.34 (8.8%)	1.90 (12.5%)
4,000	2.68 (17.6%)	3.80 (25.0%)

[a] Figures are the estimates of α obtained from Table B-2, Appendix B.

and 99 percent of all work injuries, involve only temporary disability.

In 1970, the typical compensable injury in manufacturing entailed less than $150 in medical expenses and about $375 or so in lost wages,[11] for a total pecuniary cost to the employee of roughly $525. While an employer will certainly bear the costs of machine damage, lost production and employee replacement, it is not at all clear that the employer will absorb the entire $525 in employee costs.

Not only does workers' compensation typically pay but half of lost wages to the employee,[12] but the insurance premiums are usually very unresponsive to changes in compensation costs. Hence, for a plant with a 5 percent injury rate (close to the manufacturing average) and 1,000 employees, an extra injury will add only about $180 to premiums.[13] For plants with fewer employees, the proportion of the $525 added employee cost borne by employers is even smaller: $134 for plants of 500 employees, $73 for plants of 100, and $31 for plants of 25. Only for plants with over 3,000 employees would an extra temporary-disability injury add as much as $338 ($525 less lost wages not covered by workers' compensation) to the employer's premium cost.

If the psychic costs of pain and suffering are assumed to be nil, and if wage premiums are (optimistically) assumed to make

[11] The medical cost figures for states with no limitations were obtained from Table 10.11 in National Commission on State Workmen's Compensation Laws, *Compendium on Workmen's Compensation*, Washington, D. C., 1973, p. 153. 1970 spendable daily earnings were $24.34, as reported in National Commission on State Workmen's Compensation Laws, *Report*, Washington, D. C., 1972, p. 55. The typical manufacturing lost-workday case involves the loss of fifteen days of work, according to U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Injuries and Illnesses, by Industry, 1972*, Washington, D. C., 1974, p. 69.

[12] National Commission on State Workmen's Compensation Laws, *Compendium on Workmen's Compensation*, p. 120.

[13] The calculation was made using data from Louise Russell, "Safety Incentives in Workmen's Compensation Insurance," *Journal of Human Resources*, Summer 1974, pp. 361-375. The calculation was made for a "typical" firm where total premium costs more or less equal total compensable costs from injuries. Because premiums are to a large degree based on class experience, and only slightly affected by the experience of an individual firm, this assumption is not inconsistent with the observation that the cost of an extra injury in a particular firm does not increase its own premiums by an equal amount.

The responsiveness of the premium to changes in compensation costs is higher in plants with higher injury rates. Russell constructs examples for plants with injury rates of 2 percent and 5 percent; the latter was chosen for our calculations because it is closer to the manufacturing average (1972) of 4 percent for lost workday cases.

up for the $188 in lost wages which workers' compensation does not cover, then the tax required to equate employee and employer costs ranges from zero (for plants of 3,000 employees) to around $300 (plants of 25 employees), with medium-sized plants of 500 requiring a tax of around $200. These figures establish the lower bound for a "tax" on a typical temporary-disability injury. An upper bound can be estimated by assuming that wage premiums do not make up for uncompensated employee losses and that psychic costs are (say) equal to pecuniary costs. Here, the "tax" must equal the lower-bound "tax" plus uncompensated wage losses in the typical case ($188) and psychic losses (say $525). Thus, the upper bounds of this "tax" are some $700 higher. For a plant of 500, a "tax" in the range of $200 to $900 per injury would probably be appropriate in the typical temporary-disability case—with more severe cases being taxed to a greater extent and non-severe cases to a lesser degree.

Estimating the required taxes in cases of death and permanent disability is simply not possible, because the psychic losses are so important and so difficult to measure objectively. These taxes must needs be set arbitrarily: however, even if permanent disability and death cases were taxed at triple the compensation-costs involved—comparable to the upper-bound tax/compensation ratio in temporary disability cases—the average tax for all injuries in firms of 500 employees would only rise to $1,700. The lower-limit tax/compensation ratio would imply an average fine of a little less than $400. Hence, required fines on work injuries lie in a "moderate" range—a range which would tend to produce injury rate reductions of between 2 percent and 10 percent (see Table 6). The moderate fines, amounting to perhaps 1 percent or less of payrolls,[14] and the modest reductions they would induce, are consistent with the conclusion in Chapter II that safety is probably not seriously underprovided by most firms.

Before we reach the discussion of occupational health alternatives, it is worthwhile emphasizing that the injury "tax" must be levied on the basis of individual firm experience. Taxing on the basis of average industry injury experience would not provide the proper incentive to the individual firms, because the firm could not

[14] Premiums to finance insurance against claims for coal miners' black lung disability payments, in contrast, range from 7 to 11 percent of payrolls. See Morris Goldstein and Robert S. Smith, "The Predicted Impact of the Black Lung Benefits Program on the Coal Industry," Technical Analysis Paper No. 14 (U.S. Department of Labor, Office of the Assistant Secretary for Policy, Evaluation, and Research, 1973), p. 2.

significantly affect the industry injury experience—and hence could not reap the rewards of improving its own injury record. This is precisely the defect in Congressman Burton's plan to provide greater incentives for safety by increasing benefit levels. Because workers' compensation premiums are set, to a large extent, on the basis of industry experience, the typical firm could not avoid very much of the added costs he proposed by reducing its own injury rate. Workers' compensation premiums are largely fixed costs to a firm—fixed costs that cannot be reduced by its own actions unless the plant is very large. Hence, the safety incentives inherent in workers' compensation are small, and only by a change in the entire premium-determination formula can these incentives be increased.[15]

Occupational Health

It is clear that the characteristics of occupational illness rule out the use of the "tax" approach in a government occupational health program. Taxes require a definitive taxable event, and in most cases the onset of occupational disease is not even noticed. Furthermore, when the disease is noticed, who is to be taxed: the worker's current employer, or one of his past employers? Even if the tax liability could be shared, or set in some arbitrary way, it is quite possible that this "tax" would not serve as an incentive for employers to reduce disease-causing hazards. If employees are highly mobile, and work for several employers, any one employer would have little chance of affecting an employee's eventual risk of disease, because so many other employers would be involved. Hence, levying a "tax" in cases of diseases with long latency periods would be ineffective even if it were not impractical.

The taxing of dust levels, noise levels, and other hazards causing disease might also be considered, particularly because the "tax" would encourage hazard reduction in a flexible least-cost way. However, to enforce these taxes would require a monumental inspection and monitoring program, whose administrative costs would almost surely offset the advantages the method could offer.

Government provision of information is extremely important in an occupational health program, precisely because so little

[15] This point is made in more detail by Russell, "Safety Incentives in Workmen's Compensation Insurance."

information is known by employers and employees alike. In this respect, governmental information-dissemination is much more critical to a health program than to a safety program. Even so, one is reluctant to rely only on the provision of information, because workers may not be mobile enough or powerful enough to act rapidly upon their new information. It is not clear that the proper incentives for reducing health hazards would be expeditiously transferred to employers after the information is received.

By a process of elimination, then, it appears that an occupational health program must rely on a standards approach, despite its defects. However, there are only some 400 health standards, and the revision and enforcement problems connected with standards are lessened as the number of standards is reduced. To put it differently, if OSHA were free to concentrate only on promulgating, revising, and enforcing health standards, some of the criticism of the standards approach would be blunted. It is still important, however, that OSHA perform careful benefit-cost analyses when setting health standards, so that overall social welfare is increased by as much as possible.

Recommendations

On the basis of the arguments and findings throughout this study, the following recommendations can be made concerning the federal occupational safety and health program:

(1) The goal of absolute safety, qualified only by cost considerations in the most extreme cases, should be rejected. Because this goal apparently is supported by congressional intent and judicial decisions, OSHA will have to rely on changing the attitudes of Congress or the judiciary so that a goal can be adopted more consistent with promoting the general welfare. Perhaps the best way for OSHA to provoke a serious discussion of goals is to adhere rigidly to a benefit-cost framework in setting standards—as suggested in the case of noise control—and use the resulting conflict to state the case for more rational goals.

(2) The standard-setting approach to occupational safety should be repealed and replaced by a program which sets moderate fines on each injury, to be paid by the victim's employer. The fines should be moderate, because there is no evidence that occupational safety is grievously underprovided by employers.

(3) The largest social gains can be achieved by focusing OSHA's resources on the area of occupational health, where a

standards approach must be maintained. OSHA can, however, also increase social welfare by publicizing what is known or suspected about the causes of occupational disease.

(4) The criterion for any standard must be, "would the beneficiaries be willing to pay the costs of this standard if they were fully informed as to the hazards involved?" This criterion underlies the use of benefit-cost analysis, and must be used to prevent the diminution of social welfare from "too little" (as in the case of asbestos hazards) or "too much" (as in the case of the seat belt interlock system) protection against risk. According to this criterion, it is very doubtful that either noise standard OSHA was considering in 1975 will do anything but reduce social welfare.

(5) According to the criterion in (4), it is quite likely that standards should vary across industries. The "equal protection" argument is neither cogent nor consistent with the goal of promoting social welfare—unless, for some reason, administrative or enforcement costs of industry-specific standards are enormous.

(6) Targeting high-risk industries for highest inspection priorities will not necessarily prove productive. In fact, given the lack of measured effectiveness of the Target Industry Program and the lack of correlation between injury and compliance rates, OSHA's variant of the "worst-first" approach to inspections must be seriously questioned. It is possible that targeting the high-risk firms within an industry would be more productive.

APPENDIX

APPENDIX A: INTERTEMPORAL VARIATIONS IN WORK INJURY RATES

A simple regression of the yearly change in injury frequency rates (ΔI) in manufacturing from 1948 to 1969 against a constant (representing the trend) and changes in the unemployment rate (ΔU) yields the following results (estimated standard errors in parentheses):

$$\Delta I = \underset{(.16)}{-.12} \; \underset{(.13)}{-.46\Delta U} \qquad R^2 = .38 \qquad \text{Durbin-Watson statistic} = 1.44 \qquad \text{(A.1)}$$

The results clearly show the effects of the business cycle on the work injury rate (the rate tends to fall in recessions), but there is no strong evidence of a trend over this period.

This description of postwar injury rate experience over time, of course, sheds no light on the underlying causes. In a previous article,[1] I suggested that the long-run influences on the injury rate were related to production technology and the economic incentives for injury reduction, while the short-run influences related to changes in the proportion of new (inexperienced) workers, worker fatigue, and the pace of production. Empirically identifiable proxies for these short-run influences were (respectively) the manufacturing accession rate (A), average overtime hours worked per week (H), and the capacity utilization rate (C).

Average real hourly earnings (W) was used as a proxy for incentives for injury reduction, on the theory that highly skilled

[1] Smith, "Intertemporal Changes in Work Injury Rates," pp. 167-174.

workers are more costly to hire, train, and replace than low-skilled workers. It was hypothesized, therefore, that as skill levels (and hence wage rates) have risen over time, work injuries have become increasingly costly to employers (who must replace the injured worker, even if only temporarily, or lose that worker's output). Therefore, it was expected that as wages have risen, work injuries—other things equal—would have declined. A trend variable (T) was also included in the estimating equation to capture long-term technological changes which are likely to affect the risks faced by employees.

A regression of the yearly manufacturing work injury rate (I) on the independent variables noted above yielded results which can be summarized by the following equation:

$$I = 24.24 + .602A + .556H + .071C - 16.53W + .650T \quad \text{(A.2)}$$
$$\qquad\quad (.318) \quad (.247) \quad (.035) \quad (4.50) \quad (.229)$$

All the coefficients above are significant at the usual confidence levels (one-tail tests on all but the coefficient of T), indicating the conformance of the data to a priori expectations. The results for A, H, and C (the short-run influences) were used in making the adjustments displayed in Figure 1 in the text.

It is important to note that attempts[2] to apply the model above to the injury experience of six specific manufacturing industries over time failed to confirm these results. Why the model applies to manufacturing in the aggregate, but not to the specific manufacturing industries, is not at all clear at this point. However, it has been suggested that the small intertemporal variations in the six industry-specific injury rates and the difficulty of obtaining reliable within-industry data are major drawbacks in the attempt to reproduce the aggregate results.[3]

[2] Walter Y. Oi, "Economic and Empirical Aspects of Industrial Safety," Report submitted to the U.S. Department of Labor under contract number L-73-101, February 28, 1974, pp. 3.19-3.27.

[3] Ibid., p. 3.27.

APPENDIX B: THE JOB SAFETY MARKET: ECONOMETRIC EVIDENCE

In order for the occupational safety and health market to function properly, it is a necessary (but not sufficient) condition that wages reflect on-the-job risks and that employers respond to financial incentives (including these wage premiums) in deciding how much safety and health to "produce" for their workers. Owing to the lack of data on occupational disease, tests for the existence of these two labor market characteristics must be confined to job safety alone. The formal models and statistical tests are described in this appendix.[1]

Compensating Wage Premiums. In the absence of full ex post compensation for injuries, one would expect workers to obtain ex ante compensation in the form of wage premiums that would be sufficient to cover the losses imposed on them by injuries. If the wage premiums were not sufficient to cover these losses, workers would not be attracted to the industry or firm, inasmuch as their net wage would be higher elsewhere. More formally, the equilibrium condition that must hold across industries, assuming risk neutrality and homogeneous preferences among workers, is

$$W_{ij} - E(L_{ij}) = W^n(H_j, Z_j), \qquad \text{(B.1)}$$

where W_{ij} is the gross (observed) wage of the ith worker in the jth class of workers, W^n his net wage stated as a function of human capital (H) and other variables (Z), and $E(L)$ is his expected uncompensated losses from injury.

$E(L)$ is assumed to be the sum of the expected losses of three levels of injuries: death, permanent impairment and temporary disability (levels A, B, and C, respectively). The probability of being killed during any hour of work is $P^A a$, where a is the hourly

[1] Much of this appendix is a summary of Robert Stewart Smith, "The Feasibility of an 'Injury Tax' Approach to Occupational Safety," *Law and Contemporary Problems*, Summer-Autumn 1974, pp. 730-744.

injury rate and P^A is the fraction of injuries resulting in death; the probabilities of incurring nonfatal injuries are similarly calculated. We assume that the losses at each level of injury are proportional to the wage rate; for example, the losses from death are $r^A W$. Substituting these definitions into equation (B.1) we obtain

$$W_{ij}\,[1 - a_{ij}\,(r^A P^A{}_{ij} + r^B P^B{}_{ij} + r^C P^C{}_{ij})] = W^n\,(H_i, Z_j). \qquad \text{(B.2)}$$

Assuming that the reduction in gross wages from expected injury-related losses is less than 50 percent, we can use the approximation $\ln(1 + x) = x$ in rewriting (B.2) as

$$\ln W_{ij} = r^A P^A{}_{ij} a_{ij} + r^B P^B{}_{ij} a_{ij} + r^C P^C{}_{ij} a_{ij} + \ln W^n(H_i, Z_j). \qquad \text{(B.3)}$$

Equation (B.3) suggests an estimating equation where an individual's wage (in logarithms) is regressed against the probability of his sustaining an injury resulting in death, permanent impairment, and temporary disability, plus the determinants of his net wage (in logarithms). Data on W_{ij} and the determinants of $W^n{}_j$ were obtained for 3,183 white males from the May 1967 Current Population Survey, which contained supplemental data on wage rates and union membership collected as part of the Survey of Economic Opportunity. The independent variables included as determinants of W^n were education, experience, union membership, class of worker, occupation, demographic characteristics, geographical dummies, migration variables, and industry dummies. The probability of injury assigned to each individual was the average for the industry in which he works. The industry rate, a, is the frequency rate (disabling injuries per million man-hours) corrected to an hourly basis—that is, the published frequency rate divided by 1,000,000 so that hourly wages could be stated as a function of hourly risks. P^A, P^B, and P^C were also obtained from published sources.[2]

The results, listed on line A of Table B-1, strongly indicate the existence of a wage premium connected with the risk of death, but suggest that measurable premiums for risks of nonfatal injury cannot be found. The lack of measurable premiums for risks of nonfatal injuries is not surprising because the expected uncompensated losses are very small. For example, assuming that the yearly average probability of being permanently disabled in manufacturing is around .0015, an uncompensated loss of even $20,000

[2] Data on a, P^A, P^B, and P^C were obtained by SIC code from U.S. Department of Labor, Bureau of Labor Statistics, *Injury Rates by Industry, 1966 and 1967*, Report No. 360, 1969.

would create a yearly salary differential of only $30. In contrast, the uncompensated losses attendant to death are likely to be huge (particularly so because there is no way to compensate the victim ex post), so that even though the probability of death is very small the expected uncompensated losses are large enough to be measured. The coefficient on line A, Table B-1, suggests that the uncompensated losses associated with death are around $2,600,000—and perhaps more if for one reason or another the estimated differential is not fully compensating. This estimated loss can be calculated by noting that workers would be willing to sustain a 64 percent wage cut to reduce the hourly chances of death by one in a million. At $4.00 per hour, this implies that 1,000,000 workers would be willing to pay $2.56 apiece—or $2,560,000 in total—to avoid the loss of one life. They therefore act as if the value of saving a life is around $2.6 million.

The limitations of this study should not be overlooked. First, the probabilities of death and injury assigned to each individual were those of the three-digit industry in which he worked. This procedure, the only one which could be used with the data available, creates an errors-in-variables problem which produces a downward bias to the least squares estimator. Second, the wage rate used was computed by dividing usual weekly earnings by usual weekly hours, with the possibility that wages were understated due to reporting of net rather than gross weekly pay. Third, the size of the estimated loss associated with death is ten times larger than that reported by Thaler and Rosen.[3] While Thaler and Rosen used occupational risk of death—thus presumably having a smaller errors-in-variables problem—their data were also confined to a small number of very risky occupations. Because the only people attracted to the most risky jobs are those who estimate the smallest losses associated with death (in a sense, those least averse to the risk of death), it is not surprising that the Thaler-Rosen estimate is lower. However, because the magnitudes of the estimates are so diverse, and because of the other problems mentioned above, it is desirable to verify our findings by using another body of data.

The attempt at reproducing the results on line A of Table B-1 was accomplished using 1973 Current Population Survey data on white males. This attempt offers several improvements over the

[3] R. Thaler and S. Rosen, "The Value of Saving a Life: Evidence from the Labor Market," Paper presented at the National Bureau of Economic Research Conference, Washington, D. C., November 30, 1973.

Table B-1

ESTIMATES OF PROPORTIONATE COMPENSATING RISK PREMIUMS

	Data	Estimated Coefficient (in Millions) on Hourly Risk of: Death	Permanent Partial Disability	Temporary Disability
A	Earnings, 1967 CPS, all industries	.636* (.265)	−.033 (.039)	−.002 (.002)
B	Earnings, 1973 CPS, manufacturing	.390* (.103)	—	—
C	Wage rate, 1973 CPS, manufacturing	.382* (.097)	—	—

* Indicates significance at the .05 level using a one-tail test.

Note: Estimated standard errors are in parentheses. Number of observations: regression A—3,183, regression B—5,458, and regression C—3,426.

original study. First, only employees in manufacturing industries were included in the sample in order to avoid, at least to some extent, variations in job disutility or union strength correlated with job safety which might exist if (say) coal mining or construction workers were included. Second, it was possible separately to identify workers paid by the hour, as well as their hourly wage. Thus, in addition to a sample where hourly earnings were computed, a smaller sample consisting only of hourly workers—most likely production workers—was used to verify findings and measure the extent of any biases resulting from the use of the computed rate. Third, because the expected uncompensated losses from nonfatal injuries are so small as to be virtually undetectable with the data and statistical tools at hand, their effects were constrained to be zero by dropping the two variables measuring nonfatal risks from the estimating equation. Using a priori information to eliminate these variables reduces both the intercorrelation among the injury variables and the chances that spurious relationships will be measured. The variable measuring risk of death in each industry was computed from 1970 injury rate statistics.[4]

[4] The 1970 data were obtained from U.S. Department of Labor, Bureau of Labor Statistics, *Injury Rates by Industry, 1970*, Report No. 406, 1972.

The (constrained) reproduction of the earlier study yielded estimates shown on lines B and C of Table B-1. Both computed earnings and the hourly wage rate yield almost identical point estimates of the wage premium, which can be seen to be smaller than the premium estimated earlier. The estimates on lines B and C imply that workers are willing, collectively, to forego $1.5 million in pay if employers undertake steps which will save one life.

The "Supply" of Safety by Employers. To test the hypothesis that the supply of job safety by employers is responsive to market incentives, let us begin with the assumption that the observed injury rate in a plant or industry is a function of the marginal costs of work injuries (to the employer), the cost of the safety inputs required to reduce injuries, the level of risk inherent in the technology, and a random component.[5] In particular, let us assume the following estimating equation:

$$a = \alpha(dM/dI) + \beta R + \gamma P_s + e \qquad \text{(B.4)}$$

where a = the injury frequency rate;

dM/dI = the change in total injury costs M caused by a change in the number of injuries, I;
P_s = the price of safety inputs;
R = the level of inherent risk;
e = a random error term; and
α, β, γ are parameters.

The estimation of α is of particular interest for our purposes, because it indicates the response of the injury rate to a change in the marginal cost of injuries. The sign and significance of our estimate of α will indicate whether financial incentives influence the injury rate, while the size of α can be used to guess the degree of effects of given financial "penalties" assessed on each injury (see Chapter V).

The empirically identifiable version of equation (B.4) was specified as follows:

$$a_k = \beta_0 + \alpha(dW/da)_k + \beta_1 W_k + \beta_2 HP_k + \beta_3 NH_k + \beta_4 A_k + \beta_5 F_k + \beta_6 PW_k + \beta_7 B_k + \gamma_1 FS_k + \gamma_2 U_k + e_k \qquad \text{(B.5)}$$

[5] For a fuller development and derivation of these and the following hypotheses, see Smith, "The Feasibility of an 'Injury Tax' Approach to Occupational Safety."

Table B-2
ESTIMATES OF EQUATION B.5

	Estimated Coefficient (Standard Error) on:											
	Constant (β_0)	dW/da (α)	W (β_1)	HP (β_2)	NH (β_3)	A (β_4)	F (β_5)	PW (β_6)	B (β_7)	FS (γ_1)	U (γ_2)	R^2
A	55.00**	$-.95^* \times 10^{-3}$	−17.90*	$.16^* \times 10^{-2}$	2.82*	−50.23	−11.78*	−.11	90.71*	$.08 \times 10^{-1}$	14.27	.82
	(31.49)	$(.45) \times 10^{-3}$	(9.73)	$(.09) \times 10^{-2}$	(1.52)	(49.72)	(3.78)	(.17)	(32.75)	$(.13) \times 10^{-1}$	(11.81)	
B	27.31*	$-.67^* \times 10^{-3}$	−9.01*	$.11^{**} \times 10^{-2}$	2.19*		−10.39*		101.00*			.85
	(12.29)	$(.34) \times 10^{-3}$	(4.58)	$(.07) \times 10^{-2}$	(.11)		(2.95)		(25.82)			

* Denotes significance at the .05 level, and ** denotes significance at the .10 level, with one-tail tests. One-tail tests are employed on all estimated coefficients, because a priori sign expectations are assigned to each. Significance tests in the context of two-stage least squares (TSLS) are only approximate, however.

where, for industry k,

(dW/da) = the compensating risk premium;
W = the wage rate;
HP = horsepower per production worker;
NH = rate of new hires;
A = the proportion of workers under 26 years of age;
F = the proportion of female workers;
PW = the proportion of production workers;
B = the proportion of nonwhite workers;
FS = firm size (average number of employees per plant);
U = the percentage of workers who are unionized;
$\alpha, \beta_i, \gamma_i$ = parameters to be estimated; and
a, e are as previously defined.

The variables W, HP, NH, A, F, PW, and B are intended to control for the inherent risk characteristics of workers and of their jobs. FS and U are proxies related to the price of safety inputs, and dW/da turns out to be one element of the marginal injury cost.

Data on thirty manufacturing industries were used to estimate equation (B.5). Data on W, HP, NH, PW, and FS related to 1963, and data on A, F, B and U were for 1960. The variable dW/da was calculated, using the results on line A of Table B-1, according to the following formula:

$$(dW/da)_k = W_k\,(.636P_k^A) \times 10^6. \qquad \text{(B.6)}$$

The results, using two-stage least squares regression procedures to account for simultaneity between a and W, are presented on line A of Table B-2. Although the coefficients on W, HP, NH, F and B all are of the expected sign and statistically significant, it is especially interesting that our estimate of α suggests that a measurable inverse relationship exists between injury costs and injury rates.

Because the statistical insignificance of the estimated coefficients on A, PW, FS and U raises questions about the adequacy of these four variables as proxies for R and P_s, it was thought prudent to re-estimate equation (B.5) excluding them in order to determine the effects on α of any initial misspecification. The results of this re-estimation are displayed on line B of Table B-2, and can be seen to be qualitatively comparable to those on line A. However, α is reduced somewhat in size compared to the earlier estimate.

Both the sign and the significance of α are consistent with the hypothesis that, across industries, work injury rates are inversely correlated with the cost to employers of injuries. In other words, in their safety efforts, employers do seem to be responsive to the cost of injuries.

APPENDIX C: EVALUATION OF THE TARGET INDUSTRY PROGRAM

The focus of this evaluation study is on measuring differential injury rate changes, pre- and post-OSHA, in targeted and non-targeted industries.[1] If, after properly controlling for changes induced by factors other than OSHA, we can detect a statistically significant difference in injury rate changes between the two sectors, the null hypothesis that the Target Industry Program has had no impact can be rejected. If, on the other hand, we cannot detect differential changes, the "no impact" hypothesis cannot be rejected. To find this would be to imply that OSHA's target program had no differential impact—or at least not a measurable one.

It is well established that industry injury rates have a sizable systematic component, which tends to keep them relatively stable over time. Appendix B, for example, presents an economic model of work injuries which explains over 85 percent of the inter-industry variance in injury rates. The model suggests that the "inherent hazardousness" of the technology and the strength of market incentives for safety are good predictors of industry injury rates. These factors can be presumed to change very slowly over time in each industry, except when a powerful exogenous force—such as OSHA is intended to be—is operative.

The simplest model of temporal change in work injury rates is, therefore, an autoregressive one:

$$I_{72}^{j} = f_1(I_{70}^{j}, I_{69}^{j}, I_{68}^{j}, E^{j}, T^{j}), \qquad \text{(C.1)}$$

where I_{72}^{j} is the injury rate in 1972 (the first post-OSHA year for which reliable data exist) in the jth industry, and $I_{68}^{j} - I_{70}^{j}$ are the injury rates immediately preceding the implementation of OSHA. The pre-OSHA injury rates are intended to control both

[1] This appendix is a brief summary of a more detailed paper. For a more comprehensive discussion of statistical problems and procedures, see Robert Stewart Smith, "The Estimated Impact on Injuries of OSHA's Target Industry Program," Paper presented at the Department of Labor Conference on Evaluating OSHA (Annapolis, Maryland; March 18-19, 1975).

for the level of, and for changes in, the technological and economic forces affecting injuries in each industry. E^j, the ratio of employment in 1972 to employment in 1970 within industry j, is included to capture cyclical changes in injury rates over that period. T^j is a dichotomous variable taking the value of unity if the industry is in the targeted sector and zero otherwise. The addition of T^j to the list of regressors if the industry is targeted permits those industries to exhibit a relationship between past and present injury rates different from what exists in the nontarget sector—reflecting the hypothesis that the target program has reduced injury rates below what they otherwise would have been. A constant term, or the combination of the constant and the lagged dependent variables, is assumed to reflect (in part) the changes in rates from definitional and reporting changes, as well as the changes generally induced by other industrial forces (rising mechanization, increased youth of workers, and so on). These changes are presumed to affect target and nontarget sectors equally.

A possible objection to this model is that injury rates are so much greater in the targeted sector that one wonders if the same model can apply to both targeted and nontargeted industries. Note, however, that the issue is not whether the target and comparison groups have the same average injury rate. Rather, the question is whether the same model applies to each sector—that is, whether the same relationship between past and present injury rates would have held in both sectors in the absence of the Target Industry Program. If not, it is obvious that the nontargeted industries cannot be used as a comparison group.

Fortunately, it is possible to conduct a limited test of the hypothesis that the same autoregressive model applies to all industries. This can be done by specifying the following model:

$$I_{70}^j = f_2(I_{69}^j, I_{68}^j, E^j, T^j). \qquad \text{(C.2)}$$

The variables are all defined as they were in equation (C.1), only here E^j is the 1970–69 employment ratio and $T^j = 1$ indicates that the industry was subsequently targeted. If the coefficient of T^j is statistically significant in a regression based on (C.2), it may be concluded that the same model did not apply to both sectors before OSHA was implemented. If, on the contrary, the coefficient of T^j is not significantly different from zero, the hypothesis that the same model applies to both sectors in the absence of the program cannot be rejected.

Because of the lack of necessary pre-1971 data in the maritime and construction sectors, the sample available for this study consists of 109 three-digit level industries in the manufacturing sector, of which seven were in the Target Industry Program. Summary data for these industries are presented in Table C-1, where it can be seen that the post-1970 injury rates are consistently larger than the pre-1970 rates—the result, in part at least, of the new data collection methods. The virtual doubling of the injury rate in logging camps, however, is suggestive of a substantial bias in the pre-OSHA data, owing to the large number of small camps omitted from the earlier sample. Logging camps were therefore eliminated from our analysis.

Equation (C.1) was specified in the following form:

$$I_{72} = AI_{70}^{\beta_1} I_{69}^{\beta_2} I_{68}^{\beta_3} \exp(\alpha + \beta_4 T + \beta_5 E)\epsilon, \qquad \text{(C.3)}$$

where A, α and β_1, β_2, β_3, β_4 and β_5 are parameters and ϵ is the error term. This form allows for injuries to be increasing, other things being equal, at a slower rate in industries which are targeted and at a faster rate, other things being equal, in industries enjoying most rapid growth. The estimating form of (C.3) is, of course,

$$\ln I_{72} = A' + \beta_1 \ln I_{70} + \beta_2 \ln I_{69} + \beta_3 \ln I_{68} + \beta_4 T + \beta_5 E + \epsilon', \qquad \text{(C.4)}$$

where ln is the natural log operator, $A' = \ln A + \alpha$, and $\epsilon' = \ln\epsilon$. If the Target Industry Program is having its intended impact, our estimate of β_4 should be significantly negative. An analogous specification of equation (C.2) was also estimated, where the coefficient on T should be zero to indicate that the same autoregressive relationship applied to targeted and nontargeted industries alike before the program began. Indeed, the results of these estimates, which are presented on lines A and B of Table C-2, suggest that the same relationship did exist before implementation of the program, because the coefficients of T are insignificantly different from zero.

Results—to 1972. Ordinary least squares estimates of various permutations of equation (C.4) are presented on lines C through F in Table C-2. The estimate on line G was made using an "instrumental variables" approach to deal with the biases caused by measurement error in the lagged injury rates.

On the whole, the results on line G seem most plausible. Not only does the coefficient on E have its expected sign, as in the other estimates, but so do the coefficients on T and the lagged

Table C-1

INJURIES AND EMPLOYMENT IN TARGETED MANUFACTURING INDUSTRIES

Industry (SIC Code)	Injury Rates[a]					Employment 1972
	1968	1969	1970	1972	1973	
(201) Meat and meat products	7.7	8.1	8.6	9.8	9.4	344,500
(241) Logging camps	8.6	7.7	8.5	16.1	16.1	68,900
(242) Sawmills and planing mills	7.6	7.1	7.1	9.5	9.7	216,700
(243) Millwork, plywood and related products	6.1	6.1	5.9	7.9	7.5	204,800
(244) Wooden containers	7.3	6.4	6.5	6.9	6.8	28,200
(249) Miscellaneous wood products	7.0	7.4	6.7	7.0	7.5	93,401
(379) Miscellaneous transportation equipment	7.5	8.0	6.7	9.9	10.5	103,200
Manufacturing sector	2.8	3.0	3.0	4.0	4.3	19,090,000

[a] Injury rate is number of injuries with lost workdays per 100 employees. Rates for 1968–70 were converted from a base of 1,000,000 man-hours by dividing the published rate by 5.

Sources: U.S. Department of Labor, Bureau of Labor Statistics, *Injury Rates, by Industry*, for 1968, 1969, 1970. Injury rates for 1972 and 1973 were obtained from Bureau of Labor Statistics printouts; 1972 employment data were also obtained from the Bureau of Labor Statistics.

injury rates. In particular, one would expect that the coefficient on the 1970 injury rate would be by far the largest of the three coefficients on these lagged rates and that the coefficient on I_{69} would be negative—reflecting the expectation that an increasing injury rate from 1969–70 should lead, other things being equal, to a higher 1972 rate. Further, having controlled for 1969 and 1970 rates, one might reasonably expect that the 1968 injury rate would have a small independent effect on the 1972 injury rate. These expectations are much more closely fulfilled in the estimate on line G than elsewhere.

The 2.8 percent decrease in injury rates estimated to have occurred as a result of the Target Industry Program is very small when compared to the standard error of the estimated decrease. Because the estimated effect is so small and imprecise, the null hypothesis that the program had no effect cannot be rejected.

Results—to 1973. Measuring the impact of the Target Industry Program through 1973 can provide more useful information on the subject of OSHA's efficacy. Using 1973 data not only provides another opportunity to estimate program effects, it can also be argued that measuring the effects over 1969–73 is a fairer test than measuring the effects over 1970–72 because inspection efficiency and employer response take time to develop. Therefore, a measurement of program impact to 1973 may be somewhat more conclusive than the earlier measurements running through 1972.

The procedure followed to estimate the programmatic impact through 1973 was the same as used earlier—that is, ln I_{73} replaced ln I_{72} in estimates of equation (C.4) and its variants. One difference was that lack of published yearly employment data by industry forced a redefinition of E. In the 1973 estimating equations, E is defined as the ratio of June 1973 employment to June 1970 employment in the industry. There was no need to re-estimate the 1970 equations, because the earlier results apply equally well in this case. Also, for reasons discussed previously, the 1973 sample excluded industry 241 (logging camps).

The results using 1973 data are reported in Table C-3. The estimated program effects are virtually identical to those reported for 1972 (Table C-2) in sign, size, and significance. The other estimated coefficients, with one minor exception (ln I_{69} in equations A–D), also show very similar signs, sizes, and patterns of significance. The estimates are so similar to those for 1972 that confidence in both sets of results is enhanced.

Table C-2
ESTIMATES OF REGRESSION EQUATIONS, U.S. DATA, 1972

	Dependent Variable	Estimated Coefficient (Standard Error) on:						
		T	$\ln I_{70}$	$\ln I_{69}$	$\ln I_{68}$	E^{**}	Constant	R^2
A	$\ln I_{70}$	−.063 (.059)		.428* (.109)	.572* (.110)		.020	.96
B	$\ln I_{70}$	−.069 (.058)		.443* (.108)	.559* (.109)	.497* (.256)	−.463	.96
C	$\ln I_{72}$	.069 (.125)		.206 (.233)	.589 (.236)		.522	.77
D	$\ln I_{72}$	.007 (.128)		.179 (.231)	.609* (.234)	.604* (.331)	−.055	.77
E	$\ln I_{72}$	.094 (.124)	.398 (.207)	.036 (.246)	.361 (.262)		.514	.78
F	$\ln I_{72}$	.032 (.127)	.405* (.205)	.005 (.244)	378 (.259)	.616* (.327)	−.074	.78
G***	$\ln I_{72}$	−.028 (.147)	.785* (.248)	−.263* (.111)	.218 (.253)	.810* (.403)	−.058	.73

* Indicates statistical significance at the .05 level, one-tail test.

** E is defined in the regression on line B as the ratio of employment in 1970 to that in 1969. In the other regressions, it is defined as the 1972/1970 employment ratio.

*** In this regression, the injury rates in 1962–64 were used as instruments for the injury rates in 1968–70, respectively.

Note: Number of observations in each regression: 108 (regressions A–F), 107 (regression G).

Table C-3

ESTIMATES OF REGRESSION EQUATIONS, U.S. DATA, 1973

	Estimated Coefficient (Standard Error) on:						
	T	$\ln I_{70}$	$\ln I_{69}$	$\ln I_{68}$	E	Constant	R^2
A	.065 (.156)		−.013 (.289)	.746* (.294)		.648	.64
B	.003 (.157)		−.116 (.290)	.837* (.294)	.561* (.286)	.085	.66
C	.098 (.154)	.517* (.257)	−.234 (.306)	.450 (.324)		.638	.66
D	.036 (.155)	.513* (.254)	−.334 (.306)	.543 (.324)	.556* (.282)	.079	.67
E**	−.006 (.175)	.861* (.296)	−.214 (.133)	.029 (.301)	.796* (.341)	.009	.62

* Indicates statistical significance at the .05 level, one-tail test.

** In this regression, the injury rates in 1962–64 were used as instruments for the injury rates in 1968–70, respectively.

Note: Number of observations in each regression: 108 (A–D), 107 (E).

Table C-4

ESTIMATES OF REGRESSION EQUATIONS, WORKERS' COMPENSATION DATA

Dependent Variable: $\ln I_{72}$

	Coefficient (Standard Error) on:						
	T	$\ln I_{70}$	$\ln I_{69}$	$\ln I_{68}$	E	Constant	R^2
A (California)	.020 (.071)	.802* (.148)	−.028 (.168)	.179 (.131)	−.166 (.158)	.084	.96
B (Wisconsin)	.069 (.147)	.861* (.063)			−.471 (.104)	.107	.76

* Indicates significance at the .05 level, one-tail test.

Note: Number of observations in each regression: 65 (California), 89 (Wisconsin).

Sources: Data used in regressions for California are from State of California, Agriculture and Services Agency, Department of Industrial Relations, *California Work Injuries*, 1968–72; for Wisconsin, unpublished data provided by State of Wisconsin, Department of Industry, Labor and Human Relations, Research and Statistics Bureau, Risk Management Section.

Results—Workers' Compensation Data. A source of potential bias in the above estimates arises from the possibility that inspections in the target sector prompt more accurate keeping of the new injury records than is found among uninspected firms. If this were the case, our estimated "program effect" would represent a confounding of the "reporting effect" with whatever impact the program has had on injuries. To test this hypothesis, it is necessary to find injury rate data, by industry, compiled from records not subject to change over this period.

Data from workers' compensation sources are the best for this purpose. Two states have data, by industry, for the required years: Wisconsin and California. Data from 65 California industries were used in reestimating the most complete specification of equation (C.4), but the Wisconsin data base did not contain injuries (by industry) before 1970. Therefore, only a truncated version of the complete estimating equation was empirically identifiable for Wisconsin. These state estimates, which are relatively free of the problems caused by reporting requirement changes and unreported injuries, are presented in Table C-4. The estimated program effects are qualitatively similar to those reported earlier, lending support to the finding that the program has not had a statistically significant effect on work injury rates.

Conclusion. All tests made suggest that the Target Industry Program has had a negligible effect on work injury rates.

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The study applies cost/benefit analysis to the OSHA noise standard (an example of a standard that provides more benefits than are desired), evaluates the potential and actual effects of OSHA on work injury rates (noting that the typical establishment will be visited by an inspector about as often as we are visited by Halley's Comet), and recommends specific changes in the federal job safety and health program.

Robert Stewart Smith teaches labor economics at the New York State School of Industrial and Labor Relations, Cornell University. In 1973–74 he was responsible for the safety and health area within the Office of Evaluation, Assistant Secretary for Policy, Evaluation, and Research, U.S. Department of Labor.

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168